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Birmingham: George Hailstone, 29, Grange Road, Smethwick.
Cardiff: H. Griffiths, Messrs. J. Williams & Sons, Ltd., Globe Foundry, Cardiff.
Sheffield and District: R. W. Kemlo, 6, Lees Hall Road, Meersbrook, Sheffield.
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Newcastle-on-Tyne: H. A. J. Rang, Cleveland Road, North Shields.

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Forthcoming Events.

MAY 31.

British Foundrymen's Association (Newcastle-on-Tyne Branch).—Annual Meeting and Dinner.

JUNE 21—24.

British Foundrymen's Association.—Annual Convention in London.

NOTES AND COMMENTS.

Oil-Fuel in Great Britain.

The development of the use of oil-fuel in this country during recent years has given rise to the impression that it is destined largely to oust coal from its present position; and this idea has been fostered by the extended application of oil-fuel in our Navy. Under some conditions oil has considerable advantages over other fuels, and these have led to its use in destroyers and other small vessels, which use is to be continued on a larger scale. But it is wrong to suppose that liquid fuel is to be solely used in future battleships and cruisers; coal must necessarily continue to be their main source of motive power. Even were oil fuel adopted entirely for naval work, it does not follow that other consumers of coal will substitute oil. The navies of the world do not exist for the purpose of making a profit; they must have the fuel which is most suitable for them as engines of war and have it irrespective of cost. Commercial concerns, on the other hand, are obliged to consider costs, and whatever may happen as regards the Navy, they will be guided by ordinary economic principles. Their choice of a prime mover, either afloat or ashore, is a question of money mainly, if not solely. It has been shown that although the Diesel engine consumes only one-third of the weight of fuel used by the best type of steam plant, yet for a given power with coal at 18s. per ton and oil at 42s. per ton, the annual cost of running the steam plant would be less than that of the Diesel engine, when all items of expense are taken into consideration. At the present moment, however, the price of fuel oil is far above 42s. per ton, having risen to such a degree that in America it is something like £2 11s., and when carriage comes to be added to such figures as these it is clear that for any ordinary purpose the English manufacturer is not likely to desert coal for oil.

The question of supply, too, is most important. The coal mined throughout the world amounts to practically one thousand million tons annually. The oil output is nearly fifty million tons, derived, according to Professor Lewes, approximately as follows:—United States 64 per cent., Russia 21.5 per cent., Spain 3.9 per cent., Dutch East Indies 3.4 per cent., Roumania 3.0 per cent., and India 1.9 per cent. No other country produces more than 1 per cent., except Mexico.

Petroleum is not absolutely non-existent in the United Kingdom, for small quantities have been found in North Staffordshire, Yorkshire, and Dumbartonshire; but since 1906 none has been obtained. The oil shale industry of Scotland, also, produces over 3,000,000 tons of shale per annum, the average yield of oil being 25 gallons per ton. It is clear, however, that we have no available supplies of any importance in this country. Taking the whole of the British Empire, of course, the matter assumes a different aspect; but there is still the transport difficulty to be overcome, and so in all the circumstances the general displacement of coal by oil for ordinary industrial and commercial purposes seems still far distant.

In metallurgical work the use of oil fuel assumes a different aspect. While cost is certainly a consideration, it is becoming more than ever recognised that first cost in fuel may often be over-ruled by other considerations affecting the product being made. Calorific value in relation to cost must also be regarded in relation to the effect on the product and the convenience of application. To take the question of oxidation only, the possibilities of different fuels assume a new aspect when this feature is considered. The ready possibility of protecting the metal from the oxidising influence of the furnace gases has proved a valuable feature in oil-fuel working, and this, combined with the ease of heat regulation and control, has done much to establish oil firing in non-ferrous work. But the question next arises as to whether the same results cannot be got without dependence on oil fuel. There is little doubt that in the future the electric furnace will solve many of these problems, and it is to this development we may look rather than to the adoption of oil in place of coal. One important feature of electrical power is that it is not essentially dependent on any particular fuel; and while some fuels, of course, will at the moment allow cheaper generation of electric power than will others, any fuel can ultimately be so converted. It appears quite probable that though the advantages of oil will give that fuel a good run, ultimately that and other fuels will chiefly find application (so far as metallurgical work is concerned), as a means of generating electric power. It must be remembered that though electricity is now very widely used in industry, its developments are still practically in the infantile stage. The last few years has seen the adoption of much higher voltages, allowing cheaper distribution, and greatly increased efficiency in plant and generation; so that while under some conditions electricity may now be ruled out on account of cost, this is quite open to alteration as time advances. With our large resources of coal, also, the possibilities are greatly increased. The present movement is towards the further recovery and utilisation of the by-products which are largely lost in consuming coal as such, and with the rise of the internal combustion engine, it has become a much simpler matter to save many of the constituents of coal, and apply for power those others which are usable in the gas engine. There are numerous and complex considerations governing the use of different fuels, but they all tend to more perfect utilisation of whatever fuel is adopted. In the face of this it is not logical to predict that any outside fuel will oust coal as our chief fuel, even though temporary considerations may appear to indicate that tendency.

Heat Losses in the Electric Furnace.

Among the various problems that have to be faced in the design of electric furnaces is that of heat losses; and this is an important matter as affecting the efficiency of the furnace compared with that of other classes. It will hardly be questioned by those conversant with electric furnace design that this has been the cause of poor efficiency in many furnaces, and that the reduction of heat losses will go far to increase the value of such furnaces for metallurgical operations. This was clearly pointed out in a Paper read by MR. F. A. J. FITZGERALD, before the recent International Congress of Applied Chemistry at New York, in which the author emphasises that in the design of an electric furnace one of the first things to be considered in avoiding heat losses is to make the rate of generation of energy per unit volume of charge as high as is compatible with other considerations, for in this way the saving of heat losses may be largely prevented. A series of experiments was made in which a furnace charge was heated to a certain temperature, and the effect of increasing the rate of generation of energy was determined by comparing the kw.-hours required to heat a given charge. Typical results were:—

Rate of generation of energy.	Energy per kilogramme of product.
88 kw.	1.7 kw-hours.
93 kw.	1.6 kw-hours.

Thus by increasing the rate of generation of energy by 5.7 per cent. the energy consumption was reduced 5.9 per cent.

Another point of great importance in furnace design, in order to avoid heat losses, it was pointed out, was to keep the external surface of the furnace as small as possible. In a resistance furnace using 746 kw. the charge was heated to a temperature somewhat above 2,000 degrees C., and maintained at that temperature for some hours. The furnace, as originally constructed, had an outside surface of 860 sq. ft., excluding the foundation. The design was afterwards changed so that the outside surface was 570 sq. ft. Determinations of the energy consumption per kilogramme with the two designs of furnace gave the following results:—

Surface of furnace.	Energy per kilogramme of product.
160 sq. ft.	6.1 kw-heurs.
570 sq. ft.	5.0 kw-hours.
Reduction 34 per cent.	Reduction 18 per cent.

Having done all that is possible in the way of perfecting the design of the furnace so as to avoid unnecessary heat losses, the final step is to provide the best heat insulation possible. Experiments were made on the total loss of heat with different kinds of materials mainly used in furnace construction. The results, given in a table in the Paper, show that "red building brick" and "insulating building brick" are better heat insulators than either firebrick or silica brick or manganese brick.

Annual Convention of British Foundrymen's Association.

The annual meeting of the British Foundrymen's Association will be held in London from June 21 to 24. The members on the Saturday will visit the Foundry Trades' Exhibition and the Chemcial Industry and Engineering Exhibition at Royal Agricultural Hall, London, N., and will be entertained to luncheon by the organisers of these Exhibitions. For Sunday the Local Committee have chartered a steamer, and it is intended to spend the day up the Thames. On Monday evening a dinner at the Holborn Restaurant will be held. On Monday and Tuesday the following papers will be given:—"Semi-Steel," by M. Riddell (Falkirk); "The Artistic Treatment of Cast Iron," by B. J. Fletcher (Headmaster of the School of Art, Leicester); "The Alloying of Aluminium," by C. H. Ivenson (London); "Small Castings," by W. H. Hatfield, M.Met. (Sheffield); "Air Volume Changes in the Cupola," by F. J. Cook (Birmingham); "The Economics of Industry and Education," by Alexander Hayes (London). Arrangements are being made to visit some of the following works:—Fraser & Chalmers, Limited, Erith, Kent; Callender's Cable and Construction Company, Limited, Belvedere; the Royal Arsenal, Woolwich; Vickers, Limited, Erith; J. & E. Hall, Limited, Dartford; the General Omnibus Company, London; the Mint, London; Geo. Kent, Limited, Luton; and the Davis Gas Stove Company, Limited, Diamond Foundry, Luton. A strong local committee has been formed consisting of leading gentlemen in the foundry industry in the London District.

A London School of Engineering.

L.C.C. School of Engineering and Navigation.

The following notes on the London County Council School of Engineering and Navigation, High Street, Poplar, E., may be of interest to some of our readers :—

This School has been established by the London County Council to enable persons in the mechanical and electrical engineering and shipping industries of the Poplar and neighbouring districts to acquire an intimate knowledge of the principles which underlie the work on which they are engaged, instruction being given in physics, chemistry and mathematics, as well as in the more practical subjects dealt with in the drawing offices, chart room, engineering laboratories and workshops. In addition, provision has been made for holding classes in carpentry and joinery, pattern-making and electrical wiring.

Day classes are also held for the purpose of preparing navigating officers for the Board of Trade Examinations and giving instruction to boys intending to go to sea. There is also a day technical school for boys who intend to enter the engineering trade as apprentices or otherwise.

The school is well equipped with modern appliances. In the Mechanical Engineering Department there is a 50-b.h.p. triple-expansion experimental steam engine, a 50-ton testing machine, an ammonia and carbonic acid refrigerator, a 10-h.p. petrol or oil motor, and other apparatus. In the Electrical Engineering Laboratories there are various types of measuring instruments, direct and alternating-current generators and motors, transformers, motor-generators, a tramway controller and various types of switchgear, etc., and in the Engineering Workshop there is a large assortment of modern machine and other tools of sufficient size and power to make the instruction given of real practical value.

The following students are ineligible to attend evening classes :—Pupils not exempt from the legal obligation to attend day schools; pupils of higher elementary schools; pupils of secondary schools without the consent of the head master of the school at which they are in attendance; pupil teachers in the service of the Council; holders of junior and intermediate county scholarships, except with the special permission of the Council.

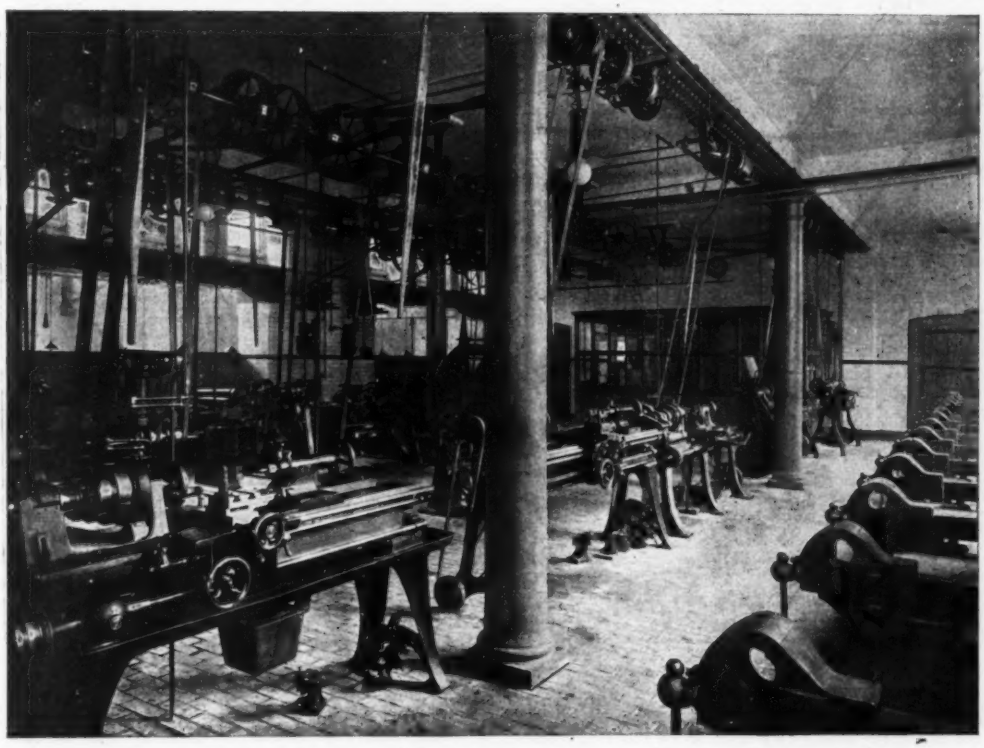

FIG. 1.—THE ENGINEERING WORKSHOP AT THE L.C.C. SCHOOL OF ENGINEERING AND NAVIGATION.

Boys under sixteen years of age attending the day technical school may not attend evening classes for technical instruction, but may, with the permission of the Principal, attend classes in literature, languages, etc. Boys over sixteen years of age may, with the permission of the Principal, attend technical classes during the last year of their attendance at the day technical school.

In the practical trade classes admission is

given to those engaged in the trade only. These classes are intended to supplement workshop practice and not to teach trades. Students in these classes are expected to attend the lectures and drawing-office work in connection therewith, and those who fail to do so are not allowed to continue the workshop practice.

The engineering workshop, which is illustrated herewith, is intended to give definite instruction in workshop processes to apprentices and others, who may have no opportunities of becoming familiar with the use of tools, except in connection with one or two special machines at which they happen to work every day. Each student attending this class is put through a regular course of work, adapted as far as possible to his special needs. Each course includes instruction in the principles of hardening and tempering, bench and vise work, drilling, planing, turning and screw-cutting, milling, grinding, toolmaking and smithwork. These lectures enable the student to receive much fuller explanations of his work than is possible in the workshop only.

ledge of pattern-making and moulding which they necessarily require to enable them to design castings in a practical manner. The class is open to all engineering students, and those who possess a sufficient knowledge of steam and applied mechanics may sit for the examination in mechanical engineering of the City and Guilds of London Institute, taking pattern-making as their subject in Part II.

Those students who are apprentices or improvers to pattern-makers have opportunities of doing more difficult and advanced work. Much of the work is carried on in association with the engineering workshop, and students are able to some extent to see the castings which have been made from their patterns as they are being machined and finished.

Evening Classes.

Persons employed in trades or occupations upon which the teaching of the school has a distinct bearing are admitted to all or any of the evening classes of the School, which they are eligible to join on

FIG. 2.—THE ENGINEERING LABORATORY AT THE L.C.C. SCHOOL OF ENGINEERING AND NAVIGATION.

The workshop is equipped with the following modern machine tools:—Fifteen screw-cutting lathes with centres varying from 8½-in. to 5-in., and representing the most recent English, American and German practice. A special brass-finisher's capstan lathe, and a special tool-maker's lathe with precision grinding gear. Two drilling machines, one universal milling machine, two shaping machines, a planing machine and a variety of grinding machines. There is also a forge and gas furnace for forging and tempering tools. The machines are all driven by electric motors, the power being supplied from the school generating station adjoining the workshop.

The Pattern-making and Moulding Department, in addition to giving instruction to apprentices and others actually engaged in pattern-making, is intended to give to draughtsmen and other engineers who may not have had an opportunity of working in a pattern-shop the means of acquiring that know-

payment of the following fees:—If earning over 30s. a week, 10s. the session; if earning 30s. or less a week, 4s. 6d. the session. Persons under 21 years of age who are *bona fide* engaged in the trade, are admitted free on production of certificates from their employers, or on showing copies of their indentures.

Evening-class students are required to follow one of the regular courses of study whenever it is possible for them to do so. These courses are based on the supposition that each student is able to spend three evenings per week at the school and, in addition, to devote about three hours a week to home work. The mechanical and marine-engineering course includes machine construction and drawing, practical geometry, a special course in mechanics and heat, practical mathematics, heat engines, and applied mechanics.

Students taking this course are advised to begin the study of electrical engineering, as the mechani-

cal and electrical branches of engineering are so closely associated and so dependant on one another, that at the present time no mechanical engineer can afford to be without some knowledge of the principles of electricity and magnetism.

The electrical engineering course includes electrical calculations, machine construction and drawing, mechanics and heat, practical mathematics, and electrical wiring.

The naval architecture course includes drawing, mechanics and heat, and practical mathematics.

Day Technical Schools for Boys.

The day technical school has been established for the purpose of giving to boys of from 14 to 16 years of age training to fit them to enter engineering works at about the latter age, as apprentices or otherwise. It has also the effect of making their education continuous, so that when they return to this school or some similar institute to attend evening classes during their apprenticeship they are able to take up the work readily. The course of study forms an excellent preparation for the examinations for apprentices for H.M. Dockyards, boy artificers in H.M. Navy, entrance to the Royal Arsenal, Woolwich, and other large works.

The boys continue their general education in mathematics and English and receive special instruction in such subjects as mechanics, electricity and magnetism, chemistry, machine drawing and practical geometry, so that when they attend evening classes during their apprenticeship they will have the groundwork of these subjects laid and will be able to continue their studies with much greater facility than would otherwise be the case.

In addition to this, the course includes a sufficient amount of workshop practice (pattern-making and metal-work) to give the boys a good general acquaintance with tools, both machine and hand, so that they may be immediately useful to their employers and begin their apprenticeship intelligently and without waste of time, and thus with steady work and industry they have a reasonable prospect of earning good wages and ultimately obtaining employment of a responsible character.

School Technical Societies.

Connected with the school are two societies, one the Association of Electrical Engineering Students, and the other the Association of Mechanical and Marine Engineering Students. The former Association was formed in 1910 by students in the Electrical Department of the School, to hold meetings for the reading and discussion of Papers; to hold debates; to pay visits to power stations and electrical undertakings; and to promote social intercourse amongst its members.

Students of the school, both past and present, are eligible for membership. The Association is controlled and managed by a representative committee of past and present students. The President is Mr. H. A. Garratt, the Principal of the School. The Association of Mechanical and Marine Engineering Students was formed with similar objects, and is similarly conducted. The President is Mr. E. W. Green, M.I.Mech.E., M.I.Mar.E.

Scholarships.

The Council awards annually 25 scholarships in connection with this school. The scholarships consists of free education and a maintenance grant of £6 for the first year and £10 for the second year. Boys, other than the scholarship holders, are admitted on passing a qualifying examination.

British Foundrymen's Association.

Sheffield Branch.

The annual dinner of the Sheffield and District Branch of the British Foundrymen's Association was held at the Grand Hotel, Sheffield, on April 11, and was of an unusually successful character. The President of the Branch (Mr. Thomas H. Firth) occupied the chair, and was supported by the Lord Mayor (Councillor S. Osborn), the Master Cutler (Mr. J. Rossiter Hoyle), Mr. Arthur Balfour (ex-Master Cutler), Professor W. Ripper (head of the Applied Science Department of the University of Sheffield), Mr. Percy Longmuir (Past President of the Foundrymen's Association), Mr. T. Swinden, Mr. W. H. Hatfield, Mr. R. M. Prescott (Town Clerk of Sheffield), Mr. W. M. Gibbons (Registrar of the University), Mr. H. C. Else, Mr. J. R. Hyde, Mr. R. W. Kemlo (secretary), and others.

The Master Cutler, speaking of the difficulty of making any profit on steel castings, said many of the largest firms in the city had given up this branch of business. It might be that more specialisation was required. The most successful steel founders were those who specialised, while those who took orders for every kind of steel castings did not make the money. From very recent information he had as to what was going on in the United States, and also in Canada, the workmen there turned out per man a considerably greater amount of work than ours did. That might have something to do with the difficulty he had mentioned. He made no aspersions on the quality of the Sheffield workmen or on what they did, but still he believed it to be a fact that men could turn out more than many of the workmen in that city did.

Mr. W. H. Hatfield said that three or four years ago he went over to the United States to investigate the question of why castings were sent over from there to this country at abnormally low prices. He found moulders producing castings at piece rates, and, taking jobs of precisely the same kind that were done in the works with which he was connected, the piecework price was 0.9d. in the States, as against 1.6d. in Sheffield. But the workmen in America earned from £3 to £3 10s. a week, whereas those in Sheffield earned from £2 to £2 10s. In the foundries in America were negroes, Poles, Hungarians, Russians, and other races who were considered somewhat behind our own in, should he say, mental development, but under expert management they were producing this work.

Mr. Balfour, referring to the same matter, said for two years he had employed moulders, chiefly on iron, in America, and he had paid Italians, Swedes, and people of that type, who had gone to America with practically nothing at all, very high wages for such work. It was important that we in this country should look to our laurels and not have economic waste through slackness. By one man working half-time they did not eventually find work for two men.

The toast of "The City and Commerce of Sheffield" was proposed by Mr. Percy Longmuir, and the Lord Mayor, as well as the Master Cutler replied.

Mr. T. Swinden proposed "The University of Sheffield," which was acknowledged by Professor Ripper and Mr. Gibbons.

Mr. Firth, in responding to the toast of "The British Foundrymen's Association," proposed by Mr. H. C. Else, said the Sheffield Branch was making good progress, and he felt sure it would do good work for the foundrymen of Sheffield and for the city generally.

Moulding and Casting Crane Work.

By Joseph Horner.

The writer proposes to take a rapid survey of the foundry practice in a modern type of crane-making shop doing a general and extensive volume of work. This embraces the whole range of moulder's work, green-sand and dry sand, by methods of bedding-in and turning over, core making, plate moulding and machine moulding, loam work and chill work, and moulding for brass and the copper alloys. The work includes all this, but in greatly different relative proportions in different foundries. In some shops the whole of these departments are not represented. Machine moulding is absent from a great many, chill work is not done in all, while brass casting is often put out. The relative proportions of the groups of work done are very different in the specialised shops by comparison with those of an all-embracing general character; different in those where light lifting tackle, hoists, cranes, etc., are manufactured, and in those where massive cranes are chiefly built. All this is fairly obvious, so that we can proceed to notice the classes of castings which are usually appropriated by the various methods of moulding, and the manner of working them out.

Green-sand moulding appropriates by far the largest quantity of work done in any crane foundry. It includes very large and very small moulds as well as those of medium dimensions. It is economical, and wholly suitable for such articles as beds, foundation plates, cheeks and frames, for most gears, for all drums of small and medium dimensions, brackets of all shapes and sizes, clutches, and an infinity of small items. It is done on the floor if large, on benches if small. The mixtures of sands are weaker or stronger to suit different kinds of moulds, or different sections of the same mould.

Dry-sand work is usually limited to some few gear wheels of small dimensions or those for special duty, to spiral drums for wire ropes with small grooves, to some of the more complicated moulds with slender and weak sections of sand, to steam cylinders of small and medium dimensions, to hydraulic cylinders for cranes and accumulators. It is rammed precisely as green-sand, but is a strong sand, and the joints have to be finned or pressed down before the moulds are dried.

The boxes or flasks used for green and dry-sand moulds include the standard ones for general service, and special ones, the former vastly predominating in crane foundries. They are mostly square or oblong in shape, but a number are round, for trolley-wheel moulds and for gear wheels, though many of the latter are moulded in square boxes, especially when of large dimensions. A certain amount of interchangeability of box parts is adopted in order that tops can be used as plain tops to cover bedded-in moulds and also to permit of using more than one middle for deep work with a top and bottom, or cope and drag.

Crane work in a general shop calls for so great a variety of shapes and dimensions in flasks that plain flasks are better than those having irregular outlines and special dispositions of cross bars or stays. Boxes with irregular outlines such as enlargements, tapered sides, sloping sides, etc., by which sand spaces and sand ramming are economised, are only reserved for specialised work, and chiefly when plate moulding or machine moulding is practised. The same remarks apply to boxes with bars cut precisely to pattern contours. With few exceptions, therefore, the boxes used are plain, with plain straight stays. Sometimes, therefore, wooden stays are fitted to suit patterns, and more liftering and rodding is done than would be necessary in flasks made specially for a job. The fittings also of the flasks are made to render them useful for general service. All except the smallest have swivels cast in the ends by which to turn them over. Many tops have ribbings cast to drive stakes against, to be used if required as plain tops. Most long boxes have eyes cast at the sides near the ends to lower them by into casting pits as well as to assist in turning them over by, and also flanges to receive back plates. A small number of massive flasks are built up in pieces with separate sides, ends, and stays, to accommodate them for moulds of different sizes and outlines.

Turning over occupies, of course, the immensely largest volume of work done in the crane foundry, as it does in others. It is more specialised in some firms than in others; and when it is, the boxes are made to suit their own patterns and no others. In almost all crane shops there are numerous patterns which come under this head, being standardised for one size of crane only or for several. These comprise such articles as crane cheeks, cross girders or stretchers, and roller frames, rollers, ground wheels, steam cylinders, safety valves, gears of all kinds, and crane beds. But a large proportion of the boxes, the largest usually, are of a general character to receive miscellaneous kinds of moulds. They range from about 12 in. to 12 ft square, and in oblong forms to similar dimensions longitudinally.

Bedding-in is adopted very extensively in the heavier sections of crane work. All cast trucks, beds, and heavy foundation plates are made in this way, as also are many of the largest cheeks and side frames, balance plates, kentledge, and balance boxes. When work of a kind is frequently repeated a permanent area is usually set apart for it in the floor, and then special boxes with stakes are used. Also a permanent cinder bed is laid down, to be renewed at intervals of six or twelve months, and with its vent pipes in permanence. Frequently too, under the cinder bed a grid is laid, having an area as large as the top box, to which grid pillars are attached, and standing up as high as the floor level receive bolts by which the top box is bolted down instead of being weighted.

A good deal of work allied to bedding-in is done in green-sand by the aid of strickles or sweeping boards. It is made in the floor and covered with a plain top, or it is swept in a bottom box part. It differs from bedding-in proper in the fact that complete patterns are uot used, but the sweeping boards are substituted with such pattern parts as cannot be swept by the edge of a board, laid and measured in. A corresponding economy in pattern work results, but this must always be set off against the moulder's extra time entailed.

Swept work is adopted extensively in some types of crane beds and foundations. Bottom and cope also are often treated thus, as when portions of a mould come up into a cope. The striking board is also regularly used in moulding gears, both spur and bevel, from tooth blocks on a wheel-moulding machine, and in large gears made from blocks or core boxes without the aid afforded by a machine.

Allied to swept work is another large group not circular, for which skeleton patterns are made—

outer framings which are rammed, leaving the interior to be formed by cores. This is adopted for beds not made in quantities and sometimes also in standard beds when self delivery of the interior would be troublesome. An advantage of such patterns, too, is that their dimensions and those of their core boxes can be readily altered. Another group is that of plain plated work, as foot-plates, base-plates, foundation plates, etc. These are made with skeleton patterns open about the centre. Usually some small cores have to be set in by measurement. The mould, made in the floor, is covered with a plain top.

The core making in a crane shop includes all kinds from the smallest cores made on benches to those of large dimensions dried in large core stoves. The practice, even in the same kind of work, differs considerably in different shops, some foremen making large numbers of dried-sand cores which others would have in green sand. The greatest differences in this practice occur in trucks, centres, and foundations, in heavy cross girders and roller frames, and in gear wheels. Still, where the core stoves are kept always going the cost of drying a few cores more or less is not a serious item; besides which it must be conceded that sounder and cleaner castings generally result from dried work than from green. The moulder certainly risks less with dried cores than with cores of green sand.

In a foundry where economy is studied, a good deal of time is saved in working with boxes that are not standard but for general service only, by moulding several patterns in a box. This is the same device which is adopted in much plate and machine moulding, but adapted for general work. Often large areas of a large box would be otherwise unoccupied, as when patterns fill one side and one end of a box, or occupy a central position, leaving corners in a square box vacant. A careful foreman will fill these spaces with small patterns, such as rollers and brackets of various kinds, which will be poured from runners coming from the main casting. In this way the disadvantages of using square boxes for round patterns or for narrow patterns is discounted.

Plate moulding has not always been adopted so extensively and profitably as it might have been. A great deal has always been done by the aid of bottom or joint boards of wood on which to ram the more flimsy patterns. The boards are usually stock boards fitted by holes to their flask pins, but used for any patterns which come within the dimensions of the boxes. The patterns are not fitted to them, but simply laid on them in suitable positions. One pattern or more, several in some cases, will be rammed at once. The board simply affords a joint face to ram on and this saves the time otherwise lost in turning over, in which a top box of sand is made a dummy to lay the pattern in, and make a joint to ram the bottom on. This represents the nearest approach to plate moulding made in some foundries. But it is a decided gain over the ordinary practice of turning over.

Plate moulding is also done on wooden boards. A board without battens has complementary pattern parts attached to its opposite sides. The pins of one box part pass into their holes in the other box part, going through holes in the board, and being cottered. The parts of the pattern are rammed on opposite sides of the board. Being parted, and the board removed, the mould is closed. The board if small will be in a single piece, but if large it must be made of strips laid side by side with open joints. As it cannot have battens the attachment of the pattern parts must maintain the strips firmly. But if not they are dowelled and retained at their ends with strips of hoop iron.

From this construction to metal plate moulding is an easy stage. But metal plates are only suitable for the smaller classes of work (apart from the help of a moulding machine). These, therefore, for small jobs can be operated in any foundry where the larger work is plated on wood. The parts for which metal plates are admirably adapted and for which they should be used are small patterns which are absolutely standardised. There are many such, some of which being used without alterations for cranes differing but slightly in sizes and powers, are suitable for moulding in large quantities on plates. They include chiefly bearings, brasses, bushes, safety valves, slide valves, clutches, small gears, pipe connections, as bends and tees, and much else of similar character. All these are readily made in iron or brass, and riveted, screwed, or soldered to metal plates.

To these plates special moulding boxes are fitted carefully, and the work is usually relegated to one area of a shop, and done by a special gang of men or youths. Benches when used, floors and tackle, are all subordinated to deal with this work and nothing beside.

Machine moulding is a natural extension of this plate moulding, because the principal difference in the two is that the same plated patterns can be put on a machine and there moulded. The outlines of the plates would have to be modified to suit some machines. But in other cases a machine having a turnover table would have the pattern parts attached to it through the table. Often also the patterns are divided between two separate plates, the top portion on one and the bottom portion on the other, and both moulded on the same or on separate machines. Frequently, too, stripping plates are used. But these methods are also all adopted in common plate moulding apart from the use of a machine, so that there is no difference in principle, but only in the methods of working out details.

The choice of a suitable kind of machine, or of suitable kinds, is not a matter of indifference. For the general run of crane work hand machines, with hand ramming followed by a presser head, or the latter used without the hand-ramming in shallow patterns, are more suitable than any others. The reason is that patterns are of all depths, and a good many have projecting parts which interfere with power ramming, and would entail preliminary hand ramming or the use of prints and cores. For the all-round work, therefore, of the crane shop, hand ramming is preferable. Of these machines there is now a very large selection of substantial types, some of which have, others have not, provision for a mechanical lift, the latter being merely mould presses. As there is a considerable proportion of deep patterns in crane work, a machine with mechanical lift is most desirable. But there is a large volume also of shallow and small work which can be done in a mould press, the patterns being then withdrawn by hand. If the choice must be between the two, then the machines which lift the pattern or lower the mould from the pattern under the control of guides and levers is much to be preferred. There is also room in crane shops where small parts are numerous for snap flask work, which saves the cost of some hundreds of small moulding boxes.

Loam work is reserved chiefly for large drums. The largest, or those within which a man can stand upright to rotate the sweeping board, are swept vertically. Those of medium diameter, but still too large to be made economically with wooden patterns are swept as loam patterns, and moulded horizontally either in green or in dry sand.

Loam work occupies a large floor area because the plates and rings have to be separated, and laid out for cleaning and completion. This is done in the vicinity of the drying stove, or stoves into which the

mould parts are charged on a low trolley. Ample crane power is required, either an overhead traveller, or a swinging foundry crane with racking motion.

Chill work is done to a moderate extent in some foundries, the castings being the truck wheels of the lighter cranes, chilled on the tread. More of this was done formerly than now since the practice of shrinking steel tyres on cast centres has become more general. These, though used on the better part of cranes, are more costly than the chilled wheels. The latter are quite suitable for all except the very heavy cranes, and they have a long life. The only part which is chilled is the tread, poured against a ring of cast iron. The rest of the wheel is poured between a sand mould at top and bottom.

Moulding and casting in brass and copper alloys is work that is often put out by crane firms to the regular brass foundries. It is not necessary nor politic to do so unless the quantity of such work done is very small. Delays are annoying, and mistakes are liable to occur when there are loose pieces on patterns or in core boxes, or strickled work has to be done. A small brass foundry can be equipped much better now than formerly. Many excellent brass furnaces are now built to burn oil, gas, or coke, and to utilise the furnace heat otherwise wasted, while occupying very little room. More economical methods of moulding are also adopted, as plate moulding and machine moulding alongside. There is a fair amount of brass and phosphor bronze about the better class of cranes. It includes brasses and bushes chiefly, but small spur gears, worms and worm wheels, are also made in gunmetal and phosphor bronze.

The Use of Mayari Iron in Foundry Mixtures.

Before the American Iron and Steel Institute recently, "The Use of Mayari Iron in Foundry Mixtures" was the subject dealt with in a Paper by MR. QUINCY BENT, of the Maryland Steel Company. The Mayari ore deposits of Cuba, he said, have furnished a wide scope for experimental work in the processes of manufacture and products of both iron and steel. The ore itself is rather unlike any other iron-bearing mineral in common use. A serpentine rock, decomposed by the action of salt, water and heat, leaves on the plateau a bed of soft ore ranging from 12 to 30 ft. in depth. The ore is quite uniform in analysis, save for a slight variation in nickel content, and in the amount of silica and alumina; careful mining, however, produces a practically constant ore, which in its natural condition is very similar to a loose clay, not having, however, the plasticity of clay. The transportation of the ore, in its natural state, also presents a serious consideration on account of the high percentage of moisture, resulting in heavy freight charges per ton of pig-iron.

Nodulising, briquetting, and sintering are all available processes for preparing the ore in desirable forms. The first of these is the method at present most largely employed, recommending itself on account of our previous experience with it in the preparation of Cornwall concentrates. The nodulising kilns are 125 ft. long, 10 ft. in diameter, and have a capacity of about eight tons of finished product per hour. Powdered coal is used as a fuel, about 400 lbs. being required to produce a ton of nodules.

After presenting an analysis of the nodules thus produced, and showing the results of "sizing tests," the author continued:—They are easy to handle in grab buckets, bins, and shutes; do not carry enough moisture to give trouble in cold weather, and, with the exception of the material finer than 60 mesh, are well suited to blast-furnace requirements. The briquetting of Mayari ore presents a unique difficulty in handling the material, making it almost impossible to fill moulds or to free the shutes or dies. It also has a peculiar quality of preventing the progress of heat through its mass. Bricks of small dimensions may be thoroughly fused on the surface, yet practically unaffected at the centre. Sintering is entirely successful with Mayari ore, and probably will ultimately be found more satisfactory than nodulising.

In summing up, Mr. Bent said:—The qualities of the iron developed in mixtures have led me to divide its uses into three classes of castings: First—all chilled castings; second, green-sand castings or semi-chilled castings; third, dry-sand castings. Under the first head are rolls, guides, crusher plates, wearing plates, die blocks, car wheels and all other castings requiring a hard surface for resistance to wear. The amount of Mayari iron to be used depends entirely upon the depth of chill required and the severity of the service to which the castings are to be put. Ordinary uses range within 15 per cent. to 40 per cent. limits. Our experience with rolls has been most satisfactory, both as to increased life and as to strength and quality of surface. Rolls for both hot and cold work have shown that we can expect from 25 to 50 per cent. increase in life. Guides have given as high as 100 per cent. increase in service, while reports as to crusher plates, etc., have compared quite favourably with manganese steel.

For green-sand work, where also a hard surface is required, yet where machine work must be done, leaving a fair and uniform surface of close texture, Mayari iron has given most excellent results. Some of the uses are sand rolls, pipe balls, bending dies, valve bodies, piston rings and shear blades, the percentage of Mayari being from 10 to 30 per cent.

Under the third heading come castings where a fine finish is required, or a machine-wearing surface involving both strength and closeness of grain, such as engine cylinders, valves, guides, slides, etc. This class of casting requires a Mayari addition of 8 to 15 per cent.

For all the above classes we have found it desirable to keep the phosphorus in the mixture about 0.5 per cent. In general, we say that Mayari iron accomplishes all that can be gained by the addition of cold-blast charcoal iron, with better results as far as wearing surface is concerned. It is superior to any steel additions, inasmuch as its shrinkage and contraction is normal as compared with ordinary foundry iron; that it does not gain its strength by a decrease in carbon content, as in semi-steel, and, finally, that it does not have the tendency to chill locally, due to cold or wet spots in the mould.

The nickel or chromium does not segregate either in iron or steel. The nickel seems to have counteracting effect upon the chromium as far as brittleness is concerned. A little loss is encountered in the Cr. percentage as the mixture passes through a cupola, but the nickel remains unaffected.

It is our belief that fluidity of the foundry iron is a little increased; the metal is very clean, and a reduction in our defective castings has resulted. There is present in the iron a small percentage of vanadium and some titanium; how much these elements influence the results of our tests is a matter of conjecture. One would naturally attribute the iron's qualities to chromium and nickel. That our ratio—two parts of chromium to one part of nickel—is the right relation for all purposes is hardly conceivable; only experience can develop all the changes within the range of possibility.

Making a Solid-End Cylinder in Loam.

By Sidney G. Smith.

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The casting in question (see Fig. 1) is 84 in. diameter, 18 in. deep, by 1 in. thick outside, and 1¼ in. thick on the ribbed solid end, with one external and one internal flange, and six faced bossed openings of sizes varying from 10 in. downwards, situate at various angles around the casting. This piece is one that forms the bottom part of a filter plant arrangement. When several of these castings are required, the chief points to consider are (1) the making of tackle to form the inside, so that once made the same tackle may be used for each casting; (2) that the tackle be made so that the inside can be liberated quickly, and with as little labour as possible after pouring, to allow contraction to take place freely.

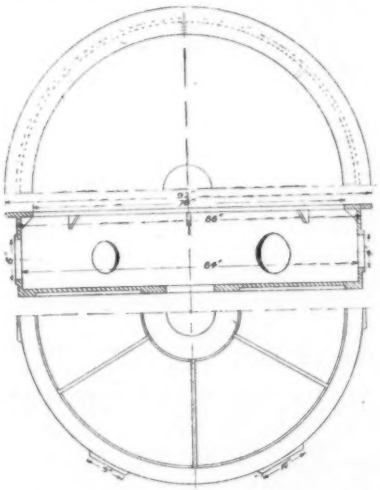


FIG. 1.—SECTIONAL SKETCH OF SOLID-END CYLINDER.

As there is an internal bracketed flange in this short length, the making of the tackle for repeated use and quick liberation is rather more complicated than usual. Care has to be taken that one piece of tackle does not foul another piece, either by a hole, bolt or staple when putting together or liberating; at the same time the holes, bolts and staples must correspond.

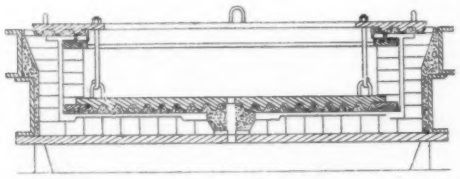


FIG. 2.—SECTION OF COMPLETE MOULD ASSEMBLED.

Fig. 2 shows in section the complete mould assembled. Fig. 3 shows the bottom part of the mould with striking board set, and in Fig. 4 is depicted the top plate with striking board and finger set to form the internal flange. Fig. 5 shows the striking board removed, and the cake in position to cover the internal flange and carry the brickwork. In Fig. 6 the striking board is replaced, the brickwork completed, and the prodded cake plate (which when turned over forms the top surface of the solid end) in position. Fig. 7 shows the top part dressed, blacked, bolted up, turned over, and slung up over the bottom part, ready for closing.

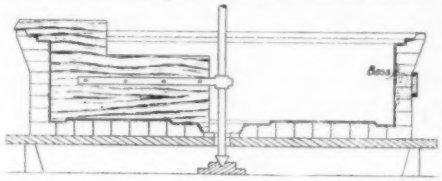


FIG. 3.—BOTTOM PART OF MOULD WITH STRIKING BOARD SET.

Tackle.

Fig 8 is the top cake plate A with runner and riser holes, also provisional holes for bolting up. Fig. 9 is the cake plate B for covering the internal flange. This plate or ring is divided into four by means of cutting cores, and the parts are held together each time by fish-plates. One piece is key-shaped, being a starting piece when liberating after pouring. Fig. 10 is the solid cake plate C; this is cut through from the centre hole to the circumference, holes being cast in to bolt to pieces of rail, taking the spring out of the plate when in use. It is split and bolted together again on one side on account of its liability as a solid plate to fracture right through when stoved, owing to unequal expansion and contraction when drying. Three large staples are cast in for fastening to the top plate. Fig 11 is the extended part D of the cake plate, and is made in four pieces, as otherwise it could not be liberated for contraction of the casting without breaking. Eight holes are cast in to correspond with holes cast in place C. The plates are bolted together, loose nut uppermost, and a small staple is cast in one of the quarters to facilitate liberating. In Fig. 11 are also shown the two plates C and D bolted together before being turned

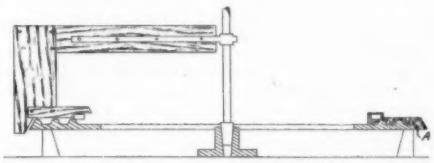


FIG. 4.—TOP PLATE WITH STRIKING BOARD SET.

FIG. 5.—CAKE PLATE B IN POSITION ON BRICKWORK OF INTERNAL FLANGES.

over, preparatory to lowering on to the brickwork (see Figs. 6 and 7). The whole of this tackle can be used for each casting, thus avoiding any remaking.

Moulding.

When proceeding to make the mould, the bottom plate (Fig. 12) is levelled on three short stands,

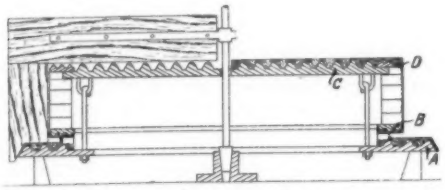


FIG. 6.—STRIKING BOARD IN POSITION WITHOUT FLANGE FINGER.

before which the spindle cross is placed underneath. The spindle is put in the cross and the mould board fixed to it, setting the board to a size stick. The bottom plate having been evenly distanced from the

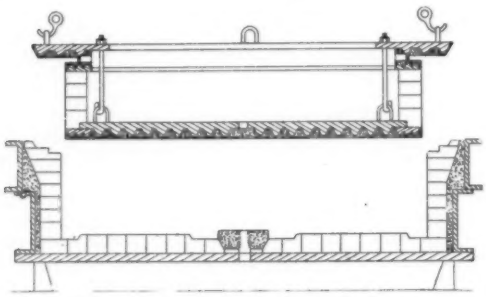


FIG. 7.—MOULD READY FOR CLOSING.

bottom edge of the board in opposite places, bricking is commenced (see Fig 3) The bricks of the bottom layer are laid on a thick layer of loam, ¾ in. apart, the spaces being filled in with ashes when the brick-

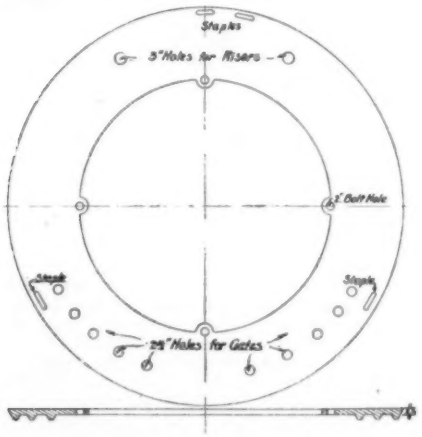


FIG. 8.—TOP CAKE PLATE (A, FIGS. 4 & 6.)

ing is completed. The brickwork is roughed with loam, which is allowed to stiffen before striking off with fine loam. When the loam has been dried, the sizes are checked with size sticks prior to dressing and blacking. A casing of wrought or cast iron is carried around the brickwork and rammed with floor sand, two or more inches allowance being made for that purpose. The brickwork and casing remains intact for a large number of castings, if care is exercised when lifting each casting out of the mould.

The bossed openings before mentioned, one of which is shown with core print attached, are bedded into the loam after being well stiffened or par-dried, allowance at these places being made in the brickwork for that purpose. When finally setting these at the various angles, a full-size flange-shaped circular wood template showing each boss is rested on the bottom of the mould, and each boss is set and bedded in the loam accurately to the lines on the template. Before its removal, when the loam around the bosses has set stiff, they are withdrawn. The core prints

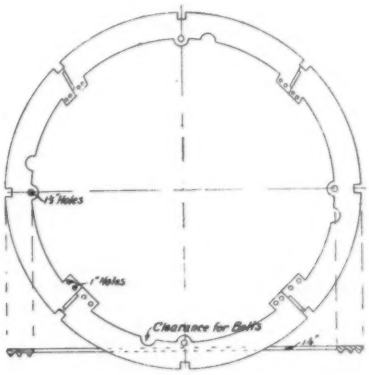


FIG. 9.—CAKE PLATE TO COVER INTERNAL FLANGE (B, FIG. 6.)

on the bosses are 3 in. long and go through the brickwork. Before the mould is closed, the cores are inserted loosely into the prints, and afterwards are pressed up and rammed from the casing with floor sand after the top part is lowered on.

Proceeding with the top and inside part of the mould, the plate A is levelled on stands; the board, spindle, and cross are set; and the internal flange finger is screwed on the board at this stage (see Fig. 4). A course of bricks is then carried under the finger to form the back of the internal flange and bearing for the cake plate which covers it, and when

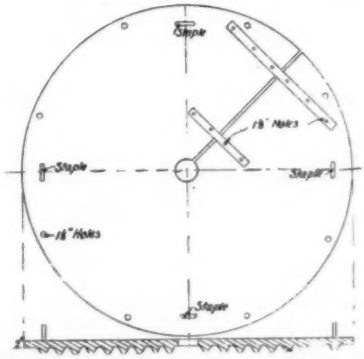


FIG. 10.—SOLID CAKE PLATE (C, FIG. 6.)

this is roughed and finished off the board is removed and the flange par-dried with fires rested around.

Fig. 5 shows cake plate B, which has been struck up separately set, in position on the brickwork forming the internal flange. This plate is dried over the same fire that dried the flange which it covers, and at the same time the eight brackets which support this flange in the casting are marked off and cut out before it is turned over for placing in position. Fig. 6 shows the striking board replaced, minus the flange finger.

The brickwork is then completed, and the cake plates C and D, which have been previously bolted together, are placed on the brickwork. The brick-

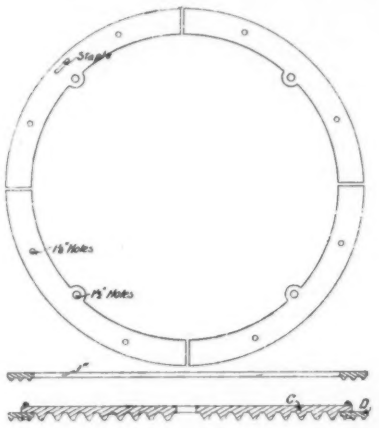


Fig. 11.—Extended Cake Plate (D, Fig. 6.) Lower Sketch shows C & D Bolted Together.

work and prodded plates are then roughed with loam, which is allowed to stiffen, and finished off with fine loam. After the plates are bolted together securely the whole is turned over for closing (see Fig. 7).

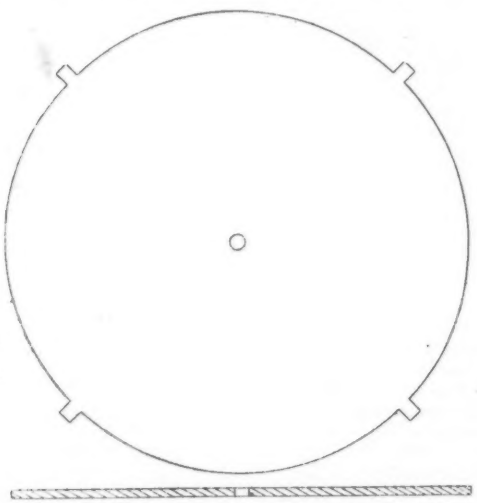


Fig. 12.—Bottom Plate.

After pouring, when sufficient time has elapsed for the casting to set, all nuts and bolts are loosened, the top plate A is lifted off, and the inside plates and brickwork are removed. Contraction can then take place freely.

German Foundrymen's Association.

Annual Meeting in Berlin.

The Verein Deutscher Giessereifachleute will hold its annual convention in Berlin during May 14 and 1/ current. The programme of Papers to be presented consists of the following:—

"Steel Founding," by Th. Geilenkirchen; "Cast Iron in Electric Machinery Construction," by F. Goltze; "The Application of Coal-tar Oil in Foundry Practice," by R. Hausenfelder; "Rational Melting and Casting in the Metal Foundry," by K. Hunger; "Electric and Autogenous Welding in Foundry and other Operations," by O. Cramer; "Electric Moulding Machines," by U. Lohse; "The Usefulness of Permanent Moulds in Iron and Metal Foundries," by J. Mehrtens; "The Application of Surface Combustion in Foundries and Steel Works," by Schnabel; "A New Metal-spraying Process," by M. U. Schoop; "Progress in Briquetting for the Production of High-quality Castings," by E. A. Schott; "The Importance of Coal-dust in the Foundry," by E. A. Schott; and "Modern Core-making Plants," by J. L. Treuheit.

Reduction of Iron Ores in the Electric Furnace.

The electric furnace has already established itself as a steel refining furnace, but electric reduction of iron ore is generally regarded as being in a more tentative position. Considerable interest is therefore attached to a Paper read at the New York International Congress of Applied Chemistry by D. A. Lyon, of Pittsburg, in which the author pointed out that the electric reduction furnace was not evolved with the expectation of competing with the blast furnace, but for the purpose of developing a furnace and a process which could be utilised in those localities where blast-furnace practice, due to the high cost of blast-furnace fuel, is not feasible. Mr. Lyon stated that the following furnaces were now in successful operation:—Trollhättan, Sweden, 1 urnace, 2,500 h.p.; Domnarfvet, Sweden, 1 furnace, 3,500 h.p.; Hagfors, Sweden, 2 furnaces, at 3,000 h.p., 6,000 h.p.; Hardanger, Norway, 1 furnace, 3.500 h.p.; Heroult, Shasta County Cal., 1 furnace, 2,000 h.p. The following were also nearing completion: Hardanger, Norway, 1 furnace (extension), 3,500 h.p.; Arendal, Norway, 3 furnaces, at 3, 000 h.p., 9,000 h.p.; Switzerland, 1 furnace, 2.500 h.p.; total furnaces built and building, 32,500 h.p. The Noble Electric Steel Company at Heroult, Shasta County, California, were also installing additional furnaces of sufficient capacity to give an output of 100 tons of pig-iron a day. The difference between the electric furnace and the blast furnace in operation was that in the electric furnace the electric curent was used to replace that portion of the fuel in the blast furnace which is necessary for the melting down of the iron and the slag, and such being the case, only one-third or less of the coke that is used in blast-furnace work is needed for the reduction of the iron oxides. The main difficulties encountered in the development of the electric reduction furnace were maintenance of crucible walls and roof, and breakage of electrodes. The problems yet to be solved were those which have to d owith the voume of the shaft as comdared with the size of the crucible; te reduction in the shaft; gas circulation: the pre-heating of the ore: hte smelting of fine ores; the size of the unit; the efficiencc of the furnace, etc. As to comparative costs: for example, with coke at 25s. a ton and with electric power at £3 5s. per kw. year, the reduciny and leltinu costs of pig-iron produced would be 25s. in the blast furnace and 27s. in the electric furnace, but if the initial cost of the blast-furnace plant, the efficiency of the electric furnace, etc., were taken into consideration, pig-iron could probably be produced as cheaply in the electric furnace.

Leaves from a Moulder's Note Book.

At a meeting of the Sheffield and District Branch of the British Foundrymen's Association, on April 5th, Mr. Frank O. Gibson, of Alfreton, gave an interesting lecture, entitled "A Few Leaves from a Moulder's Note Book."

MR. GIBSON said there were many little intricacies in moulding. For example, in the venting of a green-sand job, they would find a man using a quarter of an inch vent wire to connect to the coke bed underneath his job when he had completed venting. They would find sometimes he sealed those vents up by running his finger in a wholesale way over the face of his mould, and thereby only getting a surface covering of, say, a quarter of an inch of sand, which was not enough. The better way was to give every down vent individual attention by poking a round pin into it, and thus securing at least threequarters of an inch sand on top of vents to prevent them blowing through to the face of the mould and thus producing "scabbing." Gas was lighter than the molten metal, and hence its tendency was upwards, and on the circulating of the gas in the vents sufficient sand should be there to cause it to flow back again, through to the coke bed, and out by the tube which was placed at a slant and level with the floor line. The gas outlet pipe had a defined position, which should be at the far end from the gates, so that when metal entered a mould from one end, the gas was driven to the opposite.

Another point to be carefully watched was to see that the surface of a mould was covered by the metal in a time commensurate with the general safety of the mould, and that no vents were fired until the surface of the mould was properly covered, as sometimes there was a slight explosion which disturbed the covering of sand on the down vents, and caused gas to find its way into the mould, which usually caused trouble.

Skin drying was very much in vogue to-day, and in many shops was used to an alarming extent, because the buying agent was a clerk or head store man, who could not be considered to possess too much knowledge of natural moulding sands. He (the speaker) had seen made in Logan Foundry, Belfast, as nice green sand work as any man could desire. The water used for tempering the sand was pumped up from the Logan River, which was salt at that particular point. That had the effect of hardening the surface of the moulds, and naturally helped to give tone to the green-sand work.

If asked to pronounce judgment on which division of the moulder's art greatest skill was required, he would favour green-sand moulding every time, as the highly-trained green-sand man had a delicacy of touch unsurpassed by any woman. When a lad was placed to acquire a knowledge of foundry work, he should devote at least four years to green-sand work. If his efforts had been well directed, and should he decide to branch off into the loam division, he would figure well as a loam moulder. His sand training gave him an advantage over the youth who might have devoted his whole time to loam. The loam moulder was indispensable, but the man who could turn his hand to any branch need never swell the ranks of the unemployed. Nowhere was there more need for a wide display of knowledge than in the foundry. The demands of to-day were keener than twenty years ago, and our education was not keeping abreast of the time. How many "wasters" were created by reason of neglect to peruse a first science primer? He was thinking of a job that was made in a shop where he worked fourteen years, and was made bad on two occasions by one of his shop mates. The job referred to was a centrifugal pump made in dry-sand, and on both occasions was badly scabbed. The job was given to another moulder, who was a student at one of the local evening schools, and a keen observer of men and things. The young fellow knew what was responsible for the complaint, and found a remedy. The box in which the job was made was much too large, requiring a very large quantity of sand. The young man rammed up one half of the pattern on the turn-over principle, and when he had rammed up fully three inches of sand over the bottom half of the pattern, he placed several rows of bricks direct on this level, rather open in their joints, and filled between with dry sand from the floor. He then continued his ordinary ramming, and by doing this the 3 inches of sand between the body of the pattern and the bricks was fully dried, and he thus destroyed one of the constituents which made gas. Many poorly dried moulds and cores were responsible for "wasters," or at least unsightly blisters.

Dealing with the question of casting inspection, Mr. Gibson held that there was an opportunity for the educated moulder as, in his opinion, such a man would serve the interest of both producer and client much better than a man from some of the allied trades who, in many cases, had but a very superficial knowledge of castings.

The foundry chemist also was a very necessary person, and one who had the lecturer's sympathy and respect as a man with a difficult job, having to control an unruly composition. But he would be better equipped if he were fully shod with foundry knowledge. Knowledge without practice was like a bow without a string.

He was a stout supporter of men being educated, and especially on such lines as might be useful to their future careers. The young men should at least aspire to an elementary knowledge of mensuration, chemistry, and metallurgy, together with machine construction and drawing. When those were fairly understood thoughtfulness and thoroughness were brought to bear on every move in the daily routine, and, if such were the case generally the foundryman's status would increase by leaps and bounds.

He considered that if the foundryman were as well furnished with tackle as the engineers or pattern-makers, many of their shortcomings would disappear. To get the very best from men they must give them the very best conditions. (Applause.)

Discussion.

The BRANCH-PRESIDENT (Mr. T. H. Firth) expressed appreciation of the lecture, but could hardly agree with the claims for green sand against loam moulding. Personally, he was always in favour of loam moulding, because a lot of pattern-making was saved. He was speaking of special jobs, and not of repetition work. But whether or not it was that the moulders did not know sufficient about green sand, he always found that loam work gave very much cleaner and better casting. He thought the venting of a mould was also very much more carefully looked after, and so long as a loam mould was properly dried there was very little chance of getting a "waster." He would like to know why Mr. Gibson was so keen on the green sand as against loam. He found that in Sheffield, at all events, they had too few loam moul-

ders; a good one took a lot of finding and was a very big acquisition.

Mr. Gibson said he wanted it to be distinctly understood that he drew no comparison as to the ability of any persons in different conditions. Many times when work came into a shop a foreman had to dictate as to the method and the cheaper method. Sometimes it was more economically made in loam and sometimes in sand. But, in his opinion, loam moulding did not pay quite so well as sand. The loam moulder was indispensable, without a doubt.

Mr. Percy Longmuir said he had listened with very great interest to the Paper. Mr. Gibson had raised many points—chemist, education, the difference between green sand and loam, and other matters. He knew no greater field than that of the foundry industry for the application of common-sense. In nine cases out of ten he thought the application of a little of what Mr. Gibson had so well enforced would prevent "wasters." Of course, from the psychological point of view common-sense was one of the senses that could never be taught. He did not know that it was lacking in the foundry more than in any other industry, but there was certainly a field for its application in the foundry. In regard to the delicacy of touch that was so characteristic of the green-sand moulder, he endorsed what Mr. Gibson had said. There were many castings—and Sheffield could answer that better than any other town in the country—wherein green sand or skin-dried moulds were the only solution; and any of them who had had very intricate steel, zinc, or bronze castings to make would, he believed, support him in that statement. The green sand mould yielded very readily to the stresses following solidification, and in his experience he had often found that green sand, or partially or skin-dried moulds, were the solution to problems caused by contraction. Naturally, in a green-sand mould the touch must be delicate, and with intricate castings a certain amount of skill was required to produce a satisfactory result. Mr. Gibson, he continued, had expressed sympathy with the chemist. The chemist in a foundry had a "rotten" time of it. If the plant were large enough, it seemed to him that the best and only solution was to make the chemist responsible to the foundry manager, and not to have dual control. If the foundry manager had some knowledge of metallurgy, such a plan inevitably worked well, but where the chemist on the one hand and the foreman on the other were controlling, disaster was bound to follow. Dual control in any industry could never be satisfactory.

Mr. J. R. Hyde said he had had experience both from the unfortunate chemist's side and from the unfortunate foundry manager's side, and Mr. Longmuir certainly hit the point when he said that dual control was no good at all. He was very interested in Mr. Gibson's remark that a solution of water containing salt was an advantage. He would like to know the benefit of that.

Mr. W. F. Bagnall said that in regard to the lecturer's remarks on green-sand work, in a good many foundries the green-sand moulding was a very important item, and there were certain jobs that would not be satisfactory even with the best of loam moulders. He was very glad to hear Mr. Gibson use the words "art" or "craft" as applied to the moulder. He did not know that there was a craft in any other trade that required such an amount of skill and art as the production of some of the castings that were made.

Mr. Gibson, in answer to Mr. Hyde's question, said salt had the effect of drying and hardening the mould, and it was equivalent to skin-drying, without the same drawbacks. With skin-dried moulding, immediately after closing the top it might "sweat" inside, and then trouble would arise.

Gases Liberated by Carburising Agents.*

By de Nolly and Veyret (Usines de St. Chamond).

The object of this research was to enquire into the cause of explosions which occurred in the course of cementation operations. The explosions seem to be due either to outbreaks of gas which are observed with certain carburising agents at relatively moderate temperatures, or to the reaction between the hydrogen, which is abundant about 700 deg., and the air which is given off at low temperatures.

In order to prevent these explosions the following precautions should be observed:—(*a*) Avoid as far as possible carburising agents which contain animal or vegetable matter which cause an abundant liberation of gas at low temperatures. (*b*) Make use, by preference, of charcoal which has been calcined at rather high temperature, mixed with from 30 to 50 per cent. of barium carbonate. The gas evolution is then much less abundant, and the proportion of hydrogen less high. The cementation effect is a little weaker at low temperatures, but at 1,000 deg. and 1,100 deg. the difference may be neglected. We can, moreover, make use of a mixture of ordinary charcoal and calcined charcoal, or of an old carburising agent mixed with barium carbonate. (*c*) Heat slowly up to 700 deg. The air contained in the charcoal has then time to escape and the energetic gas liberation at 700 deg. is attenuated.

The cementation experiments were particularly intended for the object of elucidating the influence of hydrogen. With respect to the depth of the effected cementation, this gas does not appear to be so injurious as one might believe. Almost all the carburising agents tried have yielded practically the same thickness of carburised iron, whatever the proportion of hydrogen. The least active carburising agents are:—(*a*) Pure charcoal for cementation at 1,050 deg. (*b*) Mixtures of calcined charcoal and barium carbonate for cementation at 850 deg. In all the other experiments the depths to which the resulting cementations extended have varied little.

The considerable proportion of hydrogen found in the gases evolved by most of the carburising agents doubtless explains the following fact which has been noted by several experimenters. The core of the cemented specimen frequently presents, before annealing or hardening, a coarser grain and a greater brittleness than pieces of the same composition maintained for the same time at the same temperature, but not cemented, and it is probable that in cases where this deleterious influence is not observed, the respective carburising agent applied did not evolve any hydrogen.

The authors have indeed been able to convince themselves that the hydrogen is much more dangerous than the nitrogen, and that quite a number of the defects of badly understood origin, observed in steel, might be attributed to the presence of hydrogen. Such are the altogether abnormal extreme brittleness observed in certain cases, in which hard spots are found in parts which the microscope shows to consist of almost pure ferrite. These parts are probably seam lines of old blowholes charged with hydrogen which had decarburised the metal at the high forging temperature; for the authors have demonstrated by experiments that hydrogen decarburises the steel energetically about 800 deg. and 900 deg. and renders it brittle like glass.

*Abstract of Paper read at the New York Congress of the International Association of Testing Materials.

Works of Willans & Robinson, Limited, Rugby.

The Birmingham Branch of the British Foundrymen's Association paid a visit on Monday, April 7, to the works of Willans & Robinson, Limited, Rugby, the party numbering about thirty. The visitors were received by Mr. Stanley Johnson, assistant works manager, and under his guidance and that of other members of the staff, inspected the various shops.

The Victoria Works of the company occupy a site of about 440 acres at Rugby, adjoining the London and North-Western main line, sidings to which have been provided. It was in 1897 that the company removed to Rugby from its works at Thames Ditton, which were afterwards sold. About 1,600 men are now employed. The business of the company, especially in steam turbines and Diesel engines, has grown so fast during the last few years that it has become necessary to consider the advisability of extending the works.

The foundry, in which about 450 men are employed, is commodious, lofty, and well-lighted. It is about 350 ft. long and, including the fettler's yard, about 150 ft. wide. The two main bays have each a span of 30 ft., and there is another of 40 ft. running two-thirds of the length. The roof is glazed to give a north light, the other slopes being slated, with match-boarding underneath. For artificial light there has recently been installed Oliver flame-arc lamps. The core-drying ovens, of which there are ten, are erected beyond the main walls of the building, and are fired from the exterior.

The main foundry is well equipped with overhead electric travellers, there being five 25-ton, two 15-ton, and one 3-ton, besides subsidiary gear at various points. The light castings foundry, which occupies the shorter bay, has an overhead runway for the ladles. There are seven cupola furnaces with melting capacities ranging from 12 tons to one ton per hour. All the furnaces have air-belts. Over a dozen moulding machines are in use, the greater number being "Tambor" and the rest "Ajax" machines. Portable hot-air furnaces are used for drying out the big moulds, but the core-ovens were raised in height some four years ago, so as to take the large condenser cores. The great economy of time and room effected by being able to keep the condenser pits in use for coring up, coping and pouring, must be obvious to every foundryman.

Castings have been made here of dimensions as large as 36 ft. by 10 ft. 4 in., and in weight up to 38 tons. The pits for casting condensers are respectively 15 ft. by 15 ft. by 10 ft. 6 in. deep, 10 ft. by 12 ft. 6 in. by 11 ft. deep, 11 ft. by 13 ft. by 12 ft. deep, and 18 ft. by 18 ft. by 5 ft. deep.

The foundry output in weight of castings, including large turbine bodies, large bedplates, and small and intricate automobile work, averages 350 tons a month. The work produced comprises castings for turbine engines, Diesel engines, and high-speed engines for the Admiralty, the War Office, and some of the great shipbuilding and engineering firms. A large proportion of the foundry's time, of course, is devoted to the company's own work, the output of which comprises turbine, Diesel and semi-Diesel engines, high-lift turbo-pumps, condensing plants, and high-speed steam engines. Last year the company also turned out automobile cylinders to the number of over 8,000, ranging from the single cylinder to the "monobloc" of four or more bores. Diesel engine work, upon which the company has been engaged since as far back as 1904, is also quite a speciality in iron-founding, owing to the high physical requirements of the castings.

A wide range of sands is used in the foundry, from Birkdale sea-sand to sand from local pits, which has been found to give satisfaction in some classes of work.

The brass foundry, which is on the opposite side from the light-castings bay, is ventilated by air inlets on the Tobin principle. A noticeable feature in the equipment is a battery of Morgan's tilting crucible furnaces. These furnaces have been in use for some time, and have proved very efficient and economical. The largest will melt 600 pounds per heat, and the next size 200 pounds, and there are three or four smaller furnaces. Castings are made in aluminium, gunmetal, brass, manganese bronze, phosphor bronze, and "Etonia" bronze. The last is a speciality of the firm, and is in great demand for motor-car and aeroplane work.

A notable point in the foundry organisation is the system of indentured apprenticeship adopted by the company in 1908. Apprentices are received for all branches of moulding and core-making, and the system, which embraces a scheme of awards of merit carrying additions to the weekly pay, has been found to yield very good results. A very good feeling, in fact, exists in the foundry between employers and employees, and there is much evidence of satisfactory co-operation in this department.

The machinery is run entirely by electrical power. This is generated by both steam engines and Diesel engines. Some of the latter have only recently been installed, and additions are contemplated. The visitors were able to see a 450-kw. Willans-Diesel engine driving a Bruce-Peebles generator supplying the current to the machine-shop and the foundry. The peak load recorded for the power-house up to the present is 850 kw.

The pattern-making department consists of three shops and a pattern-store. The plant is power-driven, and includes dimension saws, circular saws, a planer, a sand-papering machine, three band-saws, a band-saw sharpener, four lathes, a disc-grinder, tool-grinders and other grinding appliances, and quite a number of trimmers of various makes. About forty men and boys are employed in this department. For standardised work, metal and plaster patterns are largely used.

The machine-shop is equipped with tools for handling all the classes of work which have been mentioned in connection with the foundry. Some of the machine tools in the turbine bay are of particular interest, as being of Willans & Robinsons' own design and manufacture. The firm have just completed a large boring machine for dealing with the demand for Diesel-engine work.

In the erecting shop was seen the Diesel-engine bed, which is now undergoing extension, after having been already once extended. The engines are erected upon this bed and tested either upon the water-brake or with their generators. The water-brake, which by means of the pull sustained against a calculable head of water measures the brake-horse-power with minute accuracy, greatly interested the visitors. There is also in the erecting shop provision for steaming turbines upon the beds upon which they are erected. Other turbine test-bed accommodation is provided near the front of the works.

A premium bonus system is in operation throughout the works and has given satisfactory results.

A Cheap Pipe Pattern.

By J. R. Moorhouse.

Occasionally the pattern maker is called upon to depart from his customary and orthodox methods of pattern construction, especially in the case of breakdowns, where time counts and is the governing factor in the method adopted for forming the mould for the casting. In Fig. 1 is shown a section through a three-way pipe, only $\frac{1}{8}$ in. in thickness, with each outlet of a different diameter. This casting originally was made in malleable iron, which through a flaw

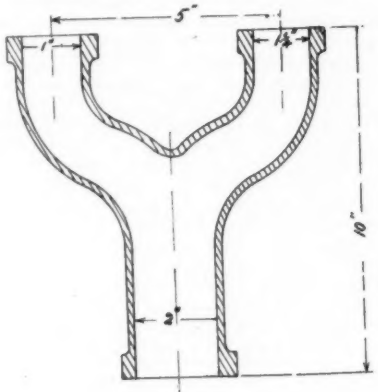


Fig. 1.

in the metal thickness collapsed. The following method was adopted in preparing the pattern for a gunmetal casting, which was installed in twelve hours from the time of the breakdown:—

From the section of the pipe in Fig. 1 it will be seen that in the ordinary way of forming a pattern and core box would mean accurate and careful working to ensure the metal thickness being uniform throughout the casting. In the method adopted a piece of timber was got out to a thickness equal to the largest diameter of the pipe, and the inside shape of the casting laid out on it. This was then sawn out on the band saw and worked round to the section, no really accurate care being taken in this,

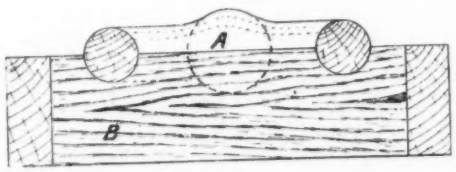


Fig. 3.

providing the curves were not too sharp so as to interfere with the free flow of the fluid through the pipe. A frame B was next made from 1-in. thick timber, and about 4 in. deep; into this were cut holes corresponding to the three diameters of the pipe outlets, and into which the already worked-out section of the core stick fitted. Two ½-in. holes are also drilled through the sides as at X, X, to allow for location dowels being driven in after the frame was cut down the centre. This made two frames that fitted each other and formed the top and bottom portions of the core box. One of these was then placed on a level board, and the core stick A put in the print recesses, being well greased so that when the plaster of Paris was run into the frame it would not adhere to it.

After having run the plaster, the core stick was removed, and the joint made straight. The top portion was then made ready, and, after replacing the core stick, it was put on the already completed half core box, and run in with plaster of Paris. When set these formed a true reproduction of the inside shape and size of the pipe. After receiving a coat of varnish they were taken to the foundry, and a core made out of them.

Coming now to the pattern proper, strips of thin leather belting were well soaked in water to make them pliable, and these were wrapped round the core stick, just leaving that portion at the outlets for the purpose of forming a print. Where the ends swelled

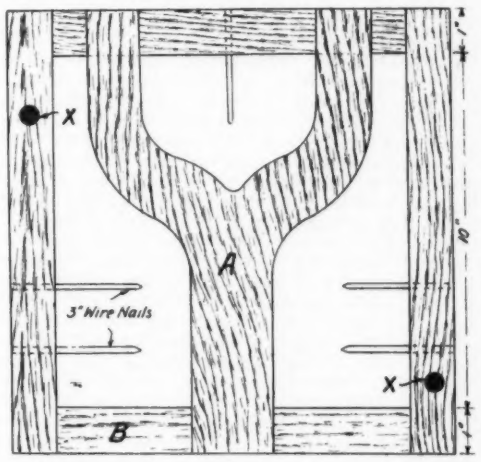


Fig. 2.

up for the connection, an extra strip of leather was put round to insure it being large enough to machine up to correct size. It will be readily understood that the casting was uniform in thickness throughout, and was, in general appearance, quite equal to a casting made from a pattern five times its cost.

Mr. T. Strömwall, hitherto associated with Stora Kopparbergs Bergslags Aktiebolag Agency, Limited, has started business under the style of T. Strömwall, 11, Queen Victoria Street, London, E.C., as a Swedish iron and steel merchant.

Messers. Sanders Brothers & Company, metal brokers, 149, Fénchurch Street, London, E.C., have been appointed British and Colonial agents for the Ver Hüttenwerke Burbach-Eich-Dudelingen A. G., of Dommeldingen, Germany, for the sale of their electric furnace steel.

Cupolas; Their Construction and Working.

By M. E. Gallon.

Before the Newcastle-upon-Tyne and District Branch of the British Foundrymen's Association, on Saturday, March 29, the President of the Branch, Mr. R. Wallis, in the chair, a Paper on "Cupolas, their Construction and Working," was presented by Mr. M. E. Gallon.

Mr. Gallon, in introducing his Paper, said that he wished specially to address himself to those who had not studied the cupola. At what date cupolas, or iron furnaces, were first constructed he could not say; according to Sir Lothian Bell there was evidence that long before the days of Tubal Cain, away in the forgotten ages and by a forgotten people, iron was made in masses that would surprise some of the forge masters to-day. But, to come down to comparatively recent times, say 150 years ago, cupolas were made square and oblong-shaped. They were built of red brick, and the inside was lined with any refractory material that the ironfounder could get. Such material might take the form of sandstone or sharp sand with a bond of clay or loam, or fireclay. Any of those would have served the purpose very well. The structure was held together by cast-iron staves placed vertically around the building. These staves in turn were held in place by wrought-iron bands passed around them and fastened at the corners. The blowing was by means of a blast main in the ground, and from which led away two leather hose pipes, attached to the free end of these being two copper nozzles. In the sides of the cupola, placed in a vertical line, were a number of tuyere holes on opposite sides of the furnace. The tuyere holes were arranged in that fashion for the purpose of accumulating iron in the furnace; for the idea was held in those days (as it was also by some to-day) that iron could only be kept hot either in the cupola or in a receiver. Therefore the copper nozzles were put into the bottom tuyere holes first, and when the metal had risen near to the bottom tuyere hole the nozzle was removed therefrom and inserted into the second row, stopping the first row, and repeating the process until sufficient metal for the job was accumulated. These cupolas served their purpose fairly well at that time, but eventually the square cupola gave place to the cylindrical or round cupola, and the rectangular or oblong cupola gave place to the eliptical cupola.

Mr. Gallon then proceeded to show drawings of different cupolas, the first being the casing of one of the early round pattern. This was built of boiler plate, strongly rivetted together; and although the square cupola, with its inconvenient corners, was departed from, the old-fashioned method of blowing the cupola was retained in this design, three tuyeres being placed in a vertical line opposite to each other in the furnace.

The next drawing was a sectional elevation of a Scotch cupola used in a Glasgow foundry in the early 'seventies. The casing of that cupola was made of cast-iron plates bolted together at the flanges. The diameter at the tap hole was 4 ft. 10 in., at the charging door it was 3 ft. The chimney was 18 in., and and the height of the charging door above the hearth about 9 ft., a usual height for furnaces at that time. The total height of the furnace was 18 ft. The only difference in the tuyeres was that instead of a number of holes long slits were placed opposite each other in the furnace. The cupola referred to melted 5 tons of metal per hour with a consumption of 20 cwt. of coke, equalling 5 lbs. of iron to 1 lb. of coke, or 4.5 lbs. of iron per sq. in. of area. The bed charge of coke was 12 cwts.

The next furnace illustrated was termed by its inventor "an expanding cupola." It was 3 ft. in diameter at the tuyere and 6 ft. diameter at its widest part. It was built to melt large lumps of metal. It had a movable tuyere arrangement. Great things were expected of this cupola, but it did not seem to have done much, since it only melted six tons per hour and took 15¼ cwts. of coke to melt 5 tons of metal, equalling nearly 6 lbs. of metal to 1 lb. of coke, and 3.2 lbs. of iron per sq. in. of area at the melting zone.

The next furnace illustrated was termed by its invented by Woodward, and named after him. The "Woodward" cupola was worked by a jet of steam placed in the chimney. The chimney could either be vertical or brought off the side of the furnace as in a blast furnace. When the steam jet was placed in the side of the furnace the charging was done by a cup and cone arrangement. When it was placed vertically in the chimney as shown on the drawing, it was charged from the charging door at the side. When the cupola was filled, the charging door was hermetically sealed and the steam turned on. The steam had the effect of causing a partial vacuum, the air being sucked in at the tuyeres. This cupola was akin to the old cupola; it melted a lot of iron in a long time.

The next drawing was of the first Stewart rapid-melting cupola. The vertical tuyere system was here departed from. There were four rows of tuyeres, made of gas piping and about 1½ in. in diameter. The idea of those tuyeres was to blow sufficient oxygen amongst the stock to capture any of the ascending gases, which were supposed to ignite and heat up the stock. The top rows of tuyeres did not seem to do much good, so they were very soon discarded. The method of blowing the "Greiner" cupola was very similar to the method of the "Steward," the only difference being that Greiner put his tuyeres around the cupola in spiral form, and they were a little larger in diameter. The "Steward" cupola shown would melt quite easily 8½ lbs. of iron per sq. in. of area of cupola at the melting zone per hour.

The next illustration was that of the "Ireland" cupola. Mr. Ireland had invented many cupolas. His method of blowing was through two rows of tuyeres similar to the "Steward" cupola. The cupola was of a form very much copied to-day, and that form was very hard to beat. The "Ireland" cupola was patented in 1856. In 1866 two of these cupolas were employed by the Bolton Iron and Steel Company to melt iron for a large angle block weighing 205 tons. Two hundred and twenty tons were melted for the job, leaving about 5 tons for gates and flows. The diameter of the cupola was 2 ft. 9 in. at the bosh and 5 ft. at the melting zone. They were blown with air cylinders and supplied with hot blast at a pressure of 14 in. of water. There were two rows of tuyeres, four of 8 in. diameter in the bottom row and sixteen of 3 in. diameter in the upper row. The iron was melted in 10¾ hours, or at the rate of 20.56 tons per hour, equalling 8.121 lbs. of iron per sq. in. of area per hour. That, he thought, was very good work for fifty-six years ago.

Turning to French cupolas, the "Voisin" was the best form of small cupola he knew, say up to 3 ft. diameter. It had an air belt around the outside which supplied two rows of tuyeres with blast. Each row pointed downwards, and from the top of the bosh to the charging door a little taper was given to the inside of the cupola. At the tuyere holes the bosh ran parallel, and just below the diameter was widened a little to form a reservoir for the metal to accumulate. Spretson, in describing this cupola, claimed for it figures which he (Mr. Gallon) was not prepared to accept The figures given were for a small cupola erected at the Polytechnic School at Anders, in France. Spretson said that this cupola was 13 in. in diameter at the bosh and at the melting zone 23½ ins. diameter. There were two rows of tuyeres, four in each row; the bottom row 3½ in. square, and the top row 2¾ ins. diameter. The rate of melting was a little less than 4 tons per hour, and the pressure of blast 8.66 in. of water. The bed charge of coke was 330 lbs., upon which was placed 1,100 lbs. of iron. The subsequent charges of coke were 55 lbs. Spretson had said nothing about the subsequent charges of iron, so it could be concluded that they remained the same as the first charge. About 51 tons of iron was melted with about 4.33 tons of coke, equalling 11.8 lbs. of iron for 1 lb. of coke. It was, of course, quite possible to do this under the best conditions, but he (Mr. Gallon) fancied the bed charge had been deducted. The metal claimed to have been melted per hour was a little under 4 tons. That was obviously a mistake, as it could not be done with the pressure of blast stated. He had gone carefully over the details of that cupola, and under favourable conditions it would not give more than 33 cwts. per hour. He thought the figures given to Spretson must have been a little under 4,000 lbs.

Turning to German cupolas ,the "Krieger" was different to anything they had yet seen. The method of blowing this cupola was to bring a couple of tuyere pipes up from a blast main in the ground and blow into an inner air chamber of the furnace. The blast entered into the air chamber and passed right around the cupola, then passed down the slits shown at each side of the cupola, then under the arches, passing through the fuel and up the centre shaft, which was square. A door in the front, swinging on hinges, allowed the whole front of the cupola at the reservoir to be opened up after the cast, leaving plenty of room for a man to draw the cupola and get in to do any repairs that were required. The main shaft was 2 ft. square, the rectangular reservoir was 2 ft. by 4 ft. One of these cupolas was capable of melting 3 tons of iron per hour. It required 3½ cwts. of coke on the bed, then a layer of 8 cwts. of metal, then a layer of ½ cwt. of coke, then 8 cwts. of metal, and so on till filled. The average, not including the bed charge, was 15 lbs. of metal to 1 lb. of coke. This cupola had given place to the German front-breasted and cylindrical cupola, which had a reservoir chamber in front placed lower than the hearth so that the metal never lay in the cupola. This allowed of the tuyeres being placed very low down.

Dealing next with the "Whiting" cupola, this was considered the best cupola in America. The "Whiting" tuyeres were considered to be an improvement on the "Colliau-Paxson" tuyeres. The difference was in the bottom tuyeres of the "Whiting" being movable, while also the proportion between the top and bottom row and the distance between the tuyeres was not so great as in the "Colliau-Paxson." In every other respect they were very similar in design. The air belt came right down to the base plate, and the cupola had a drop bottom, the same as the "Voisin." The tuyeres themselves were flared out, being about three times greater in length at the cupola lining than they were at the opening of the air belt. The top row pointed downwards, as with the "Voisin" design, and a fusable plug was placed in the bottom of the air belt in case the metal or slag overflowed the tuyere, which gave the alarm almost at once should such an accident happen.

The next drawing showed a "Mackenzie" cupola. Mr. Mackenzie was about the first man in America to break away from the old style of cupola and branch out into a new line. His cupola melted in two hours the same amount of iron as was formerly melted in the old-fashioned cupola of the same diameter in four hours, and so it became styled the two-hour furnace. It revolutionised cupola practice at that time, and became quite the furnace of the day; and it was still to be seen operated in many places in the United States. The air belt was formed within the casing of the cupola, and an apron riveted on to the casing carried down and along supported the bosh and the lining of the cupola. A slit about 2 in. in breadth ran right around the cupola, and was termed the sheet blast tuyere. The drawback to this cupola was that it bridged very quickly, and could not be run successfully more than two hours.

Next illustrated was the continuous tuyere or the "Blakeney" tuyere, named after its inventor. It was supposed to be an improvement on Mackenzie's and it was claimed to be the ideal cupola for car-wheel work. The tuyeres had an outer air belt, and the top and bottom plates were cast in segments, with curved notches cast in 4 in. apart from centre to centre. A curved cast-iron plate was fitted into every notch, so that there was a space of 3½ in., then a plate of 1 in. thick, then a space of 3½ in., and so on right around the furnace. The circular plates were to give the blast a spiral motion, so that it would swirl into the centre of the furnace, from which no part of the blast was supposed to escape without doing its proper amount of work.

The next illustration was of a large cupola used in the works of Abdendrath Brothers, of Port Chester, for melting metal for hollow ware such as sinks, down pipes, stove plates, and general plumbers' fittings, of which they cast about 60 tons per day. It was 4 ft. 6 in. diameter at the tuyeres and 6 ft. at the melting zone. It melted 12½ tons per hour. The air belt was placed in the lining of the cupola, and was 5 ft. 6 in. by 9 in. There were three rows of tuyeres, the first row being 2 ft. from the bottom; the two upper rows were 12 in. apart and pointing downwards towards the lower row; and there were eight tuyeres in each row, the bottom 8 by 5, the second 6 by 4, the third 2 by 2, with the slag hole 11 in. above the sand bottom. There were two charging doors and two tap holes, and the walls of the cupola were 18 in. thick. It was worked with a No. 6 Bakers' blower, and melted 7.68 lbs. of iron per sq. in. area at melting zone; coke ratio 9.8 metal to 1 of coke.

Reverting to Tyneside designs, Mr. Gallon showed only three, the two latter of which were his own. The first was termed the drop-tuyere cupola. The method of blowing this cupola was to have an air belt placed fairly high up the sides of the cupola, then four or more tuyeres were dropped from the belt, and the air entered the cupola anything from 10 in. to 12 in. below the air belt. The general idea of the drop-tuyere system was that the blast was supplied more regularly to each hole by that system than by introducing the blast straight from the tuyere box. Whether that was so or not he was not prepared to say. Another reason for the drop-tuyere system was that in the draw cupola it allowed the tuyeres

to be fairly low down and the air belt well out of the way of the cupola man when he was drawing the cupola. While very good results might be got with drop-tuyeres, on the assumption that for every bend in the pipe more power was required to blow the blast through, he would not recommend the system. He was of opinion that if the air from the main was introduced into the belt at a tangent, the pressure on each tuyere ought to be as regular as anything got from a drop-tuyere. The cupola in question was 4 ft. 4 in. diameter inside, air belt, 18 in. by 10 in.; tuyeres, 7½ in. by 5½ in.; and 7½ tons per hour was regularly got. The height from base plate to the charging door was 14 ft.

The next illustration was of his own tuyere boxes which he had introduced into an old-fashioned furnace. This furnace was blown through two tuyeres placed opposite to each other. While blowing with these tuyeres, both with the fan and with the blower, they never got more than 25 cwts. with the fan, or 30 cwts. with the blower, per hour. He was under the impression that much better results should be got out of a cupola of that size, and he came to the conclusion a lot of blast was being lost between the lining and the casing. The builder had left about 1½ in. space between the brick lining and the cupola casing, and had filled this with bits of tiles and other rubbish. To prevent this waste of air he (Mr. Gallon) made two complete boxes with two tuyere holes in each. These tuyere boxes went one-third round the cupola, and the tuyere holes were so arranged that they came opposite to each other at right angles; thus four tuyere holes instead of two were got. The result was that 2½ tons per hour was now being melted. Tests were made with this cupola, the coke and metal being carefully weighed and charged as follows:

Iron. Cwts.	Coke. Cwts.
9	3½
6	1
6	1
6	1
6	1
6	1
6	1

Charged iron at 1 o'clock. Blast started at 2.45, stopped 3.45. In 15 minutes 5 cwts. of metal was got; in 15 minutes, 10 cwts.; and in 30 minutes, 30 cwts.; the iron was white hot.

The final illustration was of a cupola erected some six months ago, but which he (the lecturer) had not yet had an opportunity of properly testing. The blast box went right around the cupola, and had a division in the centre with an opening at the opposite side. The air was blown into the top chamber and then passed around to the back, down into the lower chamber, then through the tuyere slits. The cupola had a drop bottom after the American fashion, and the tuyere holes were 15 ins. from the hearth. At the narrowest part of the bosh it was 24 ins. diameter, and 2 ft. 6in. diameter at its widest part. The height from hearth to charging door was 10 ft. The casing was made of an old tank boiler with the ends knocked out. It cost £6 10s. delivered into the works. For bricks and ganister the cost was 25s., and that for a man and labourer one week £4 10s. The base plate and doors were worth about £4 10s., and the four pillars about £3. The cement base cost about £2, and the improved box £5. The staging was already there.

Discussion.

Mr. Edward Smith said Mr. Gallon had condemned the idea of the blast going in below the belt, and yet he noticed in his improved cupola he was doing exactly the same thing, so that there must be some advantage in that, otherwise he could not understand why Mr. Gallon had adopted it. There was another advantage in having the blower and the side holes down below the belt; if by some reason the metal got into the blower hole, it could easily be taken out. A good plan was to have one hole just a little lower than the other, with a little lead plate over the hole so that if the metal got in it would fuse the lead and burn through, and not block up the side hole.

Mr. Weir said that on examining the diagram of the first cupola shown he could not see a slag hole. Probably it was not necessary to put one in. He was also struck with the amount of metal produced by these cupolas. He did not approve of the drop-bottom furnace, for reasons which time would not permit him to discuss. He thought more scope should be given to the workmen in the foundries for experimental work.

Mr. Henderson asked if Mr. Gallon would state what thickness of lining he would recommend in the furnace; also would he advise the use of ordinary bull-nose pricks or prefer some of the patent blocks that were on the market? Could Mr. Gallon tell them any thing with regard to the height of the charging door from the bottom of the furnace, whether there was any advantage or otherwise in having a high charging door?

Mr. Gallon, in reply, said that the arrangement in his cupola was to heat the blast, which could not be done out without making a double chamber. To get that arrangement he had been obliged to drop the air to the lower chamber. At the same time it took more power than if it went direct. With regard to fans, a big fan would give good results, but there was the danger in a fan that if the tuyeres got stopped up, or the blast went down, the supply of air could not be got into the furnace. With regard to blocks or bricks, he could not say exactly which was the best; if good brick could be got cheap, it should by all means be used. But half an inch of ganister or clay should not be put between the bricks; they should be kept as close as possible. With regard to the thickness of the lining, it depended on how long it was desired to run the furnace. If only, say, 5 tons per blow were wanted out of the furnace, there was no need to have more than 6 inches of lining. The lining was to prevent heat radiation, and the little it radiated in that time was not worth mentioning. With regard to the height from the tuyeres to the charging door, the higher the charging door could be kept the more would the heat be conserved. He had recommended the Voisin cupola as being tapered from the bosh; it was almost impossible for that cupola to hang, though it was 14 feet from the charging door to the base plate and only 2 feet in diameter. With regard to the height of the coke bed, that must be determined by one's own practice; in no case should it be less than 18 inches.

The proceedings terminated with a vote of thanks to Mr. Gallon.

Steel Castings Without Manganese.

The Alloy Steel Castings Company of Virginia (U.S.A.) is making small steel castings without the use of manganese, the composition employed being low in sulphur. The heats are manipulated in the usual way with the exception that no manganese is added, which means a considerable saving. It is stated that the castings rarely crack, and that there is much less cutting action on the hearth of the furnaces when manganese is absent. These castings, it is claimed, are solid and free from blowholes or occluded gases, while the metal is tough and quite ductile.

Sound Castings.

By Robert Buchanan.

Before a joint meeting of the Birmingham Municipal Technical School Engineering Society and the Birmingham Branch of the British Foundrymen's Association, on Saturday, March 8, MR. ROBERT BUCHANAN lectured on "The Production of Sound Castings."

MR. R. BUCHANAN explained that owing to the mixed character of the meeting he was obliged to go into a certain amount of elementary detail. He proceeded to discuss the features of different forms of cupolas, with the aid of views thrown on the screen, and pointed out the advantages of the drop-bottom cupola, and especially the avoidance of the laborious drawing after working. A receiver enabled a very shallow bed of coke to be used, and also enabled heavier castings to be produced, provided the metal was in good condition, and also made it possible to hold the metal for longer periods without any appreciable loss of heat, which was very advantageous when castings of a fairly heavy kind were wanted. In the Thwaites cupola there were three rows of tuyeres, but most ironfounders were able to do quite as well by using only two of them, and a reduced bed of coke was thus required when melting. It was generally assumed, though he did not know that it had been absolutely proved, that during the time the iron was in contact with the coke in the old type of cupola it was absorbing sulphur. But the matter of importance was the maintenance of a high temperature, so that the slag might be perfectly fluid, and that enabled the sulphur to be absorbed by the slag. The Thwaites cupola was a considerable saver of coke as compared with the old type, but, on the other hand, required considerably more fettling each day to keep it in proper working order, and that extra work had to be taken into consideration in making comparisons. On the whole, he thought the advantages were in favour of the newer type, though it called for a somewhat higher intelligence from the attendant.

With regard to the production of sound castings, first of all must be considered the influence of the blast. It was quite certain that by varying the blast it was possible to vary very considerably the character of the iron. If a large volume of blast relative to the amount of coke were used, probably the metal would be hardened, whereas with a soft blast and coke in excess it was possible actually to soften the iron. He had known an instance where an ironfounder was producing a casting about a quarter of an inch thick and using 15 cwts. of scrap to 5 cwts. of pig-iron, and the castings were being drilled and polished with emery wheels with perfect facility. That was being done mainly by blast regulation, because he found on enquiry that a 4-oz. blast was being used. He had no doubt that if the pressure had been 12 ozs. the result would have been very different. On the other hand, it was not uncommon to have a strong blast with the object of keeping down the coke consumption. He believed that hardening by over-blowing was not a very common thing, but he knew that in some cases over-blowing was done deliberately with a certain class of mixtures for certain purposes. Others had put up their blast pressures in order to get the denseness of metal they required. He knew a case where a founder casting for hydraulic work was blowing with a 20-oz. blast and getting excellent results by using material naturally soft.

A great many of the troubles which arose in the foundry were matters for which he feared they must blame the engineers. He knew a specific case of some small wheels required for certain machinery, and the teeth were worn away almost to a knife-edge within eleven months. Yet other wheels in the same position had been running as many years with much less wear. The trouble arose because the engineers demanded extremely soft castings. The engineer should allow the ironfounder a certain amount of discretion as to the quality of the castings to be supplied. An intelligent foundryman could give any quality required, and if absolute softness was insisted upon it was no use blaming the foundryman.

The question of carbon in solution had received a great amount of attention in recent years, and the solution of carbon and of gases in iron was a matter of very great importance. With regard to the softening of iron by means of the blast, the explanation seemed to be that iron at a melting temperature was in a condition to dissolve into itself more carbon than it originally contained. The speaker exhibited a sample of carbon given to him by an ironfounder in the North of England who obtained it while running a big casting, 30 cwts. in weight. The carbon in question was part of the down runner —a piece of carbon 13 in. long. As the casting ran out, the metal was drained off and the carbon was left intact. It was clear that all that carbon in the down runner was originally dissolved in the iron, but as the metal had cooled down to that point where it could not hold the quantity of carbon in solution any longer, the carbon came out of solution. This demonstrated the great value of getting the proper amount of coke in the furnace, because if there was an excess of coke it was possible for the carbon to go into the iron and cause trouble.

The solution of gases in metal had been proved by a number of people, and most recently by Professor Carpenter, who showed that there was present in all cast-iron a certain percentage of nitrogen and hydrogen; but when one considered a blowhole in a casting, it was very difficult to tell whether it was gas coming out of the metal, or whether it was steam coming from the mould. By way of illustration, Mr. Buchanan exhibited a specimen showing a large blowhole in a cylinder weighing 14 tons. The question of solution of gases in iron was rather important. There was no doubt that gases were dissolved in the metal, and it was very desirable to know the conditions under which they were either dissolved or came out. Temperature was very important. It had been explained that iron in cooling down would lose its dissolved carbon; the same thing applied to gases in solution, and it might be that during the cooling the gases were given off and by collecting in a distinctive place cause a blowhole. Another cause might be moisture in the moulds, which were intended to be perfectly dry.

In a foundry which he visited a short time ago he was rather interested to find a cast-iron chaplet in use. He was old enough to remember when nothing else was used, and he thought it was rather a misfortune that cast-iron chaplets had gone out

so completely. The manager of the foundry assured him that he practically never had a leak when using a cast-iron chaplet. The reason probably was that the cast-iron chaplet was cast in when it was perfectly clean and bright and there was no action taking place between the solid metal and the molten metal. In the case of the wrought-iron chaplet there was the oxide on it which very often refused to knit with the molten iron. The difference between oxide on the bright chaplet and the rusty chaplet was that there was no combined water present in the former; if a rusty chaplet were used, blowing would take place from the combined water present in the rust.

A point that ought to be mentioned with regard to blowholes was the question of pinholes. The lecturer exhibited a specimen of pinholing which he attributed to an excess of sulphur in the metal. It was known that the sulphur and other gases connected with it came out just as the metal was cooling, and also that casting hot was the best way to avoid pinholing.

It was a very common complaint that the "drawing" of the casting at certain points caused unsoundness. The latest and most approved method of avoiding that was by the use of chills. If the bore was too small then the chill had to be applied externally, but if the bore was large enough to admit of the casting of the chill inside, that was often done. It was not always possible to feed a casting where drawing might take place, and in that case a chill might be useful.

The lecturer then exhibited a section of a casting that was made in a permanent cast-iron mould. There had been hundreds of castings, he said, made from the same mould. Under certain conditions and for certain castings this use of permanent moulds was quite a feasible proposition. Subsequent to being cast, these castings were annealed.

Dealing with the question of liquid contraction, Mr. Buchanan explained the method devised by Mr. F. J. Cook for the testing of irons with a view to ascertaining whether they were liable to show liquid contraction or unsoundness. Exhibiting the "K" piece used by Mr. F. J. Cook for the test, the lecturer pointed out that this shape was adopted because the heavier part of a casting in such a case had a tendency to steal the metal from the other parts. The "K" test would indicate whether in the particular iron under test there was anything which made it possible for such action to take place. The condition which would give that "drawing" depended somewhat upon the melting temperature, the blast, and character of the iron. When he spoke of the character of the iron that did not amount to much more than removing the difficulties farther away; it was not explaining it.

English moulding sands were, from the ironfounder's point of view, practically infusible. Only on one or two occasions had he seen any fusion of moulding sands. One was where 10 tons of metal were run into a green-sand mould imperfectly coated with blacking, and the other was where the cores had been lavishly treated with clay wash which had lowered the fusing point of the mixture. There was some confusion in the minds of moulders as to what was meant by hardness of a mould. It did not necessarily mean that the mould was going to blow. A properly dried dry-sand mould, or a properly dried loam mould, were as hard as it was possible for them to be from the hardness point of view, and yet were perfectly permeable by gases. In green-sand work, where ramming played a very important part, hardness very often did mean impermeability.

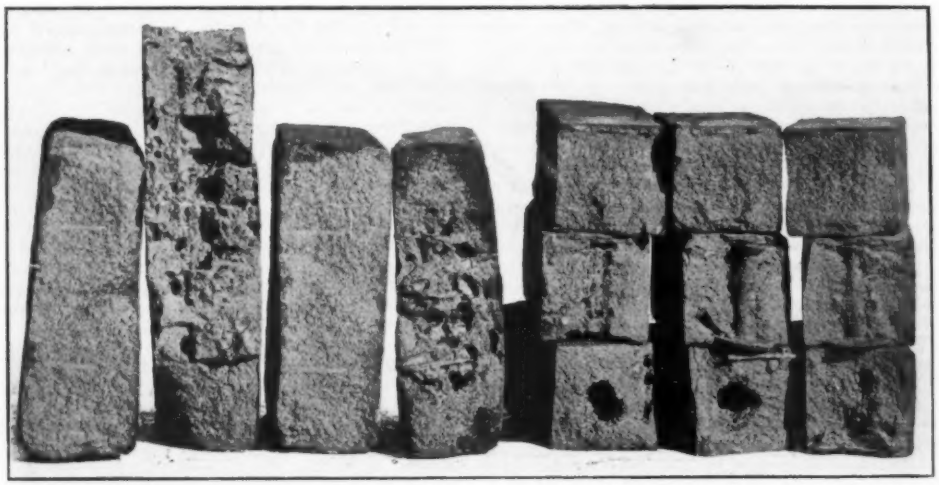


FIG. 1.—SHOWING EFFECTS OF WROUGHT-IRON CHAPLETS IN CAST IRON. TOOP ROW, TINNED CHAPLETS; SECOND ROW, CHAPLETS DRESSED WITH RED LEAD; BOTTOM ROW, BARE IRON WITH RED LEAD; BOTTOM ROW, BARE IRON CHAPLETS.

As far as he knew, there were only three kinds of dirt in castings. One was that which might be washed from runners or from the mould or core. The second was slag which might be mixed with the metal, and the third was the carbon coming out of solution when the metal was being poured. There was a special device for keeping slag out by skimming the metal. It was really a drainer or sieve which allowed only the metal to pass through and gave facilities for the slag to rise and so keep out of the mould.

Regarding test-bars, there was a tendency in the minds of foundrymen to consider the structure as being quite as important as the chemical constitution of the metal, if not even more important. Foundrymen often had the idea that a No. 1 iron was a strong iron because it was the most expensive, and that a No. 4 iron was not such a good iron.

But it was only a beginner in the business who thought that by using No. 1 iron better tests would be got than with a No. 4. There was also a growing feeling that hematite irons were not so desirable as they used to be considered, because of their carrying such a large quantity of total carbon. Hematite had the faculty of carrying more total carbon than a lower-grade iron would, and this high total carbon content had the effect of dividing up more thoroughly the granules upon which the iron depended for its strength. On the other hand, phosphorus was not looked upon as being so deleterious as formerly believed.

Discussion.

Mr. George Hailstone said he had listened with great pleasure to the Paper. Mr. Buchanan had stated that semi-steel was a product made by the mixing of cast iron and steel, giving a material with a low carbon. A friend of his who mixed semi-steel and analysed it afterwards always found that the total carbon net result was practically the same as in the pig-iron used. Supposing 70 per cent. of pig-iron containing 3 per cent. of carbon were used with 30 per cent. of steel containing 0.2 per cent. of carbon, the resulting mixture contained about 3 per cent. of carbon. Whilst not possessing the properties of ordinary cast or special cast iron, semi-steel had the same amount of total carbon with properties midway between cast iron and cast steel. With regard to the solution of carbon and gases in cast iron, he (Mr. Hailstone) had during the past two years been conducting a number of experiments with liquid contraction. Mr. Buchanan had grouped together sinking, drawing, and liquid contraction. He (Mr. Hailstone) did not think that was the correct way of dealing with it, because sinking or drawing tended to produce a casting with a solid interior by the transference of the different elements from the outside to the inside of the casting. That meant that the castings became waste because of the holes or sinks on the exterior. But liquid contraction was a property or condition by which, say, in casting a cylinder, a perfect casting was got out of the sand, but which, on being subjected to hydraulic test, leaked because of being unsound in the interior. The solubility of gases in cast iron was another important point. He had found that the more solid was the cast iron the higher the temperature when the cast-iron was poured from the cupola, provided it was not boiling. With regard to chills, it might be interesting to the Engineers' Society to know that two types of iron of the same analysis, chilling and non-chilling irons, could be taken, and really a better result got with the non-chilling iron for some purposes. Some people making cylinders had used cold-blast iron, or chilling iron, costing perhaps £1 or 30s. a ton more than other types, whereas for high-speed engines, motor-car cylinders and the like, better results had been obtained by the non-chilling irons, costing much less money. Engineers had no need to buy cold-blast iron for the purpose.

Mr. Riddle said that it occurred to him that if the soft castings referred to by Mr. Buchanan had been ground instead of being turned the result might have been quite different. Turning rather open metal often gave very unsatisfactory results. The effect of grinding was to close the grain, and often a turned journal did not wear so long as one which was ground. In making scarpments up to 5 ft. in diameter, it was difficult in turning to get the necessary polish with a very open grain. It was sometimes difficult to believe that two castings of similar composition, one ground at a high speed and polished, and the other turned, were the same metal.

Mr. J. H. Williams said that he had seen a malleable casting which when $\frac{1}{8}$ in. was taken off the surface was found absolutely hollow. It was a well-known fact that the rate of grinding with a tool would make a great difference in the surface of the article ground. If machined fast it would show a porous surface, whereas if machined at a slow rate, especially with a fairly wide tool, the latter had a burnishing as well as a cutting effect.

Mr. H. L. Reason said the speaker had pointed out the various defects in the castings under consideration and explained their causes. But as the Paper was entitled "The Production of Sound Castings," he had probably let the matter alone as being too lengthy a subject. He entirely agreed that it was best to work with a moderate blast pressure with suitable iron for the work in hand than to try and overcome difficulties in the iron by varying the blast pressure. It was quite true that desired results could be obtained by varying the blast, but the blower and gauges must be kept in good order. With reference to the necessity of soft iron in the machine shops, many who had experience of American machinery found that owing to light build and soft iron it would not stand up to hard wear for any length of time. The advent of the high-speed steel also augmented the trouble. There was no doubt that Great Britain had the position of premier tool-makers of the world, by reason of solidity of design and the use of good, strong iron that gave good wear and tear. He was very interested in the remarks about cast-iron chaplets. It seemed a pity that we departed from cast-iron to wrought iron when the former possessed all the qualities for knitting into the casting and forming a sound job. With reference to the tinning of the chaplets—did Mr. Buchanan know anything better than salammoniac? With reference to the new type of cupola with receiver, was it found that this increased the speed of melting, and was it advantageous where large castings had to be dealt with? Also, would Mr. Buchanan give the approximate composition of iron for making permanent moulds?

The Chairman said he had always been under the impression that if foundrymen fell foul of anybody it was the patternmaker. This time it was the engineer whom they attacked. He was not quite willing to admit without qualification that engineers knew nothing about castings. But he would admit that very often they did not, and that ignorance caused them much trouble, to their sorrow. As an engineer responsible for engineering work he had found foundrymen somewhat averse to trying to better the conditions surrounding the production of very large castings. One instance he recalled in his own experience was the casting of the cylinders for a very large engine. It was necessary to cast the cylinders so that the flanges, which were to be turned all over, should be perfectly free from defects, and he gave specific directions as to the proper formation of the riser, and specified that the metal should be run from the under side of the mould so that the metal would float the detached dust and slag clear of the flanges. The instructions were carried out, and the casting came out perfect. In making the intermediate cylinder the instructions were departed from, and the metal was poured from the top as usual, and the casting came out spongy all round the face of the flanges, and it had to go to the scrap heap, the casting came out spongy all round the face of the whole of their profits on the job. Sometimes the engineer got castings which could hardly be tooled, and there was certainly room for improvement in the product of both hard and soft castings. A

moderate amount of hardness was necessary to stand wear and tear, but it could easily be overdone. In many cases where milling tools were used, complaints arose because the milling tool was worn away in removing the skin of the casting. If the casting had been pickled to remove the silicious surface it could have been tooled quite easily, and the economy in tools resulting from the operation would be far greater than the cost of pickling the castings. For some reason many firms objected to pickling, some on the grounds that it spoiled the appearance of the castings, but this was not the case if properly carried out. He had used comparatively soft metal for cylinders for very large steam engines, using a high-class iron with a tensile strength of about 12 tons per square inch with absolutely perfect results. In the running of these large engines they were lubricated for a time with a mixture of pure mineral oil and flaked black lead which filled up the porous surface of the metal, and the skin of the metal was made amply hard for the special requirements and was thoroughly durable. As to the possible cause of the soft metal in contact with a chilling surface, it might be that the absence of scale which would not be formed on the surface next the chill accounted for the apparent softness, as there was no silicious surface to remove in tooling.

MR. BUCHANAN, replying to the discussion, said that as regards the total carbon, there were very few pig-iron analyses even of iron selling at fancy prices which showed a total carbon as low as 3 per cent. As regards the solution of gases, no doubt Mr. Hailstone would deal with that in his forthcoming Paper. As to the difference in metals of practically the same analyses, he did not know that he or anybody else could explain how that difference arose. As to the lathe beds cast with a chilled surface being softer than those cast in sand, it was exceptional in that the chilled part was usually harder than the part cast in sand. In this particular case the conditions were reversed. After explaining the method of testing blast pressures and the use of chaplets, Mr. Buchanan said that a 15 ton tensile metal was, of course, more reliable than a 7 ton, but the casting must also be properly designed so as to have the strains properly distributed. It was quite to be expected that grinding would give better results than turning, because the effect of grinding was to spread the grain. But grinding would not really make a good casting out of a soft one. Though a satisfactory surface was got the interior was weak. The foundryman in asking the engineer to accept a fairly hard casting which would require a certain amount of work, was asking what would be the most satisfactory casting in the long run. There had, no doubt, been a good deal of misapprehension with regard to the quality of American castings. The American irons were very soft, and it was rather singular that the Americans used ferro-manganese to a considerable extent, adding it to the metal in the ladle. The American practice was, no doubt, due to the fact that the American cokes were higher in sulphur, often containing 1 per cent. The ferro-manganese neutralised the effect of the sulphur. But that was unnecessary in this country in most cases. As to pickling, founders did not like it because it tended to make the casting unsightly. But there was no doubt whatever that picking was a saver of tools. Also, foundry prices were so low that as a rule the founder could not afford to pickle.

A hearty vote of thanks was accorded to Mr. Buchanan on the proposition of the CHAIRMAN, who said they as engineers would no doubt benefit by knowing their faults.

Lecture delivered before the Halifax Branch.

Before the Halifax and District Branch of the British Foundrymen's Association on February 15, Mr. Buchanan lectured on the same subject.

MR. BUCHANAN, in opening, advised his hearers whenever they came across a difficulty to follow his example and put it down on paper. An oft-recurring and old foundry problem was, how best to overcome liquid contraction and contraction stresses, caused by faulty design and of unequal thicknesses. For illustration he sketched a casting with a heavy cylinder-shaped body on which was a heavy bracketed flange; the angle where the bracket joined the body was constantly found to be spongy. The cause of this was liquid contraction, the metal of the lighter section drawing from the lighter, owing to the slower rate of cooling and longer period of contraction of the latter. Rather a novel method had been adopted to counteract the effect in this particular case. A small round core was placed in each bracket and the casting came out quite sound.

Regarding scabs, the lecturer said that the hardness of a mould in itself had nothing to do with scabbing, but hardness and water combined had. Water produced steam as soon as the metal entered the mould; and if there was too much steam along with the other gases, and the vents were not numerous enough to take them away, they would soon break up the face of the mould in order to escape. That was the reason that dry-sand moulds were not liable to scab, providing, of course, they were thoroughly dry. There was also an absence of water and very little venting was required in dry-sand moulding.

Regarding cast-iron chaplets he was surprised that they were not more generally used. They left no flaw in the casting, and there was no leakage similar to that commonly found where wrought-iron chaplets had been used, especially when the latter were uncovered either by tinning or red lead. He passed round photographs of sections of castings showing (1) a wrought-iron chaplet uncovered; (2) a chaplet dipped in red lead; and (3) a tinned chaplet. These showed results according to the above order. The bare wrought-iron chaplet was blown whilst the metal round the tinned chaplet was quite solid. He had made special tests of castings with screws cast in, some of them new ones with a bluish-black face and others which had been burnt red in the fire. Those which were burnt gave the best result. He attributed that to the extra amount of oxygen emanating from the blue-black magnetic oxide (Fe_3O_4), whilst the ones burnt red gave of ferric oxide (Fe_2O_3), the greater amount of oxygen being the cause of the metal blowing.

Discussion.

MR. CARRICK said he had found the lecture very interesting, although he could not agree with all Mr. Buchanan had said. He had dealt with elementary things arising in foundry work and had added a little science, thereby lifting them above the commonplace. The ordinary moulder knew as much about doing these things as the lecturer, but did not always understand why they were done. The defects in the casting which had uneven thicknesses and showed contraction stresses, they had been given to understand, were caused by liquid contraction. He thought it was due to segregation. Owing to the slowness of cooling in the heavy parts, the carbon separated out as graphite, and he thought there was a marked difference between that and the drawing away of metal from the heavy parts. The trouble had been overcome by placing a small round core through the bracket immediately under the heavy

section. He thought a chill would have had more satisfactory results. He found no trouble with castings ½ in. thick and 2 in. in the centre, but he used chills.

Mr. Love said Mr. Buchanan was difficult to criticise, as he had kept on fairly safe grounds. He had expected something quite different, and had hoped from the title of the lecture, to learn how to make good castings with bad materials, or bad castings into good ones. Dry-sand moulding had advanced a great deal. He thought it was generally known that it would practically do without vents. He (the speaker) made castings weighing 10 tons without coke beds and without a lot of vents, and they took no harm if properly dry. In Glasgow he had seen castings weighing over 20 tons, and the moulds had not had a vent wire near them. He supposed that competition was responsible for the abolition of a lot of the work which used to be put in. A moulder now was not required to put all he knew into a mould to make it safe, but to leave out as much as possible and still obtain good castings. He did not believe in the use of loam cakes in runner boxes. There was no fear of the runners cutting up if the sand was nice and dry and a good dish was made where the metal dropped. He had no doubt the cast-iron studs referred to would be found in use in many districts even yet.

Mr. Smith, B.Sc., B.A., said Mr. Buchanan had said something about the best way of preparing chaplets, which he did not quite understand, unless his notes were written down incorrectly. The screws which had been placed in moulds on purpose to note the results worked out as follows:—The new ones with the bluish-black face caused the metal to blow, but those which had been burnt red did not, the reason given for this being that more oxygen was formed by the bluish-black (Fe_3O_4), whilst those which had been burnt red gave off (Fe_2O_3). This explanation was wrong, as the proportion of oxygen was less in the first one than in the second.

Mr. Campbell said he had been struck by the frequency with which bad designs had caused trouble in the foundry and consequently to the firm. A good deal could be done by a closer connection between the drawing office and the foundry. He was not alluding to any particular firm; it seemed to be a general grievance. The foundry man feared the draughtsman and *vice-versa*. It would be much better if consultations took place between the two departments, both sides would benefit, each would appreciate the difficulties of the other, and many expensive mistakes would be avoided. The use of chills, he considered, was but a sort of makeshift.

Mr. Carrick here interjected that he did not like the last statement, and he thought it was high time a new name was found for what, at the present time, were called chills, where they were used simply to regulate the cooling and not to make hard iron. They increased the strength of a casting 25 per cent. Chilling a casting was an entirely different matter. He hoped Mr. Buchanan would bring up this matter at the next Council meeting.

Mr. Hurst stated that some time ago his firm were troubled with a run of bad material. Wheel blanks which were being cast gave 40 per cent. wasters. They had always run them in the boss and risen them in the rim. They started to run them in the rim and rise them in the boss, and got perfectly sound and clean castings. Similar trouble was experienced with other classes of work at the same time. These were coming out full of blowholes, not dirt. The whirl runner solved the problem.

Mr. Midgley asked, with regard to the specimen skimmer gates sent round for inspection for what weight of castings the examples were applicable.

Mr. Buchanan, in replying, said that the term chills at the present day was a misnomer, and he suggested that Mr. Carrick exercise his ingenuity in finding a suitable name. He had seen castings in which the chilled portion was softer than the unchilled portion. His remarks regarding liquid contraction had been objected to; he would reply: "You can call it what you please, liquid contraction or segregation." He had been told the cavities were caused by the carbon separating out, but he always thought segregation was a gathering together. There was no doubt where the metal was light the contraction stole metal from the heavy parts. He went into a good number of foundries, but although the use of cast-iron chaplets was both sounder and more economical, he only knew one firm using them. With respect to the making of good castings out of bad material, he would remind Mr. Love of the old proverb, "Silk purses cannot be made from sows' ears." Undoubtedly, Mr. Smith was right, and he accepted the correction; Fe_3O_4 blew, and the other did not. His explanation had gone; he did not know what caused it, but the fact remained. The skimmer gates were only used for comparatively small castings, up to about ¾ cwt. With regard to faulty designs, it had been lamented for some years that a better understanding did not exist between the drawing office and the foundry, and it was not fair that the foundryman should get the blame and have all the difficulty to combat.

Mr. J. G. Robinson moved a hearty vote of thanks to Mr. Buchanan, and Mr. Carrick seconded, the meeting heartily endorsing the motion.

Chemical Resistance of the Cobalt-Zinc Alloys.

Writing in "Metallurgie," Otto Barth states that of the cobalt-zinc alloys, that with 40 per cent. Co. and 60 per cent. Zn. is least attacked by HNO_3. By dissolving this in copper or by adding Co. to bronze so that the ratio of Co. to Zn. is 4; 6, a beautiful gold-yellow alloy is obtained that can be easily filed, bored, turned, forged and cast and at the same time is fairly resistant to attack by dilute HNO_3. Metals which assume a passive state in HNO_3, or which tend to assume such a state, have this passivity increased by adding a metal which forms a solid solution with them and reaches a maximum near the saturation point. Compounds are highly resistant to acids and eutectics are easily attacked. The addition of 2 per cent. cerium to aluminium raises the strength and ductility of the latter without influencing the ease with which it is worked.

A Fuel, Light and Power Exhibition will be held from Friday, October 24, to Saturday, November 15, at the City Exhibition Hall, Sheffield, under the auspices of the Sheffield Smoke Abatement Society. The managers are Walter Cawood, Limited, of 196, Deansgate, Manchester, and the exhibition offices are at 45, Bank Street, Sheffield.

Mr. A. T. Walmisley, M.I.C.E., has delivered an address to the members of the South Wales Institute of Engineers and the Association of Students of the Institute of Civil Engineers (Bristol, the West, and South Wales Branch) at the Park Place Institute, Cardiff, on the application of cast-iron, wrought iron, and mild steel sections to structural work.

Moulding a Water-Jacketed Gas-Engine Cylinder.

A meeting of the members of the Lancashire Branch of the British Foundrymen's Association was held on April 5 at Manchester, Mr. Penlington presiding. Mr. J. G. Robinson gave an address, illustrated by lantern slides, on "Moulding a Water-Jacketed Gas Engine Cylinder." The substance of the lecture has been previously reported (see FOUNDRY TRADE JOURNAL, September, 1912), and has been the subject of discussion at other Branches; but Mr. Robinson added some further observations. He said he recollected a meeting of the Branch when Mr. Simkiss strongly advocated chilling. At that time he took a different view, but he had since modified his attitude. What they were now considering was not exactly a case of chilling, as usually understood, but rather of causing solidification to take place more quickly and getting an even rate of cooling. There were two places in the cylinder where they particularly experienced trouble from sponginess, resulting in wasters. One was where the flange was connected with the inner and outer walls of the cylinder; the other was at the opposite end where solid blocks were cast to receive the studs for attaching the end cover. Various methods of casting had been adopted, one being to take a down-runner down the side of the mould and run it in at the bottom with a number of small in-gates. Personally, on anything which was cast in the shape of a cylinder, to be bored out clean and sound, he was a strong advocate of running it straight from the top, for the simple reason that if they poured the metal down a runner and let it come into the bottom of the mould so that it might rise upwards to the top, a certain amount of dust collected on the surface. In addition, the air in the mould caused oxidation on the top of the metal, and it collected scum in rising. Sometimes the metal was sluggish, and directly it caught against anything in the mould where it was rising, that would hold a little bit while the other part of the metal ran round it. He had seen cases where it had been poured in from the bottom and the scum had collected and formed a ridge; then the metal had got past, and when it came to be machined there was a bad place where the scum had stuck. By dropping the metal from the top, the hottest metal was got on the top all the way through, and, using four runners, (which they did in this case), the scum was broken up all the time and kept lively.

Sometimes a little variation arose through the drawing office and the foundry not working absolutely in conjunction; in one case a pattern would be made to bore out 16 in., and on another occasion it would be made to bore out 17 in., and at one end there was not got sufficient thickness of metal to feed another part. The difficulty was got over by using chills. At first these were too thick in one place, and caused solidification to take place underneath the flange so quickly that the metal up above could not get down to feed another part. The result was drawn places underneath the flange. A satisfactory result was obtained by having a chill 1¼ in. thick underneath the thick parts on the bottom of the cylinder and a chill ⅝ in. thick under the flange.

Several cylinders after being out a few years had cracked because no provision had been made for the expansion of the metal when it became very hot. That had been remedied by leaving an open space so that the body of metal on the inside of the exhaust pipe was separated altogether from the outside walls of the cylinder, and when it got hot it could expand.

Underneath the flange there was rather a small body of sand, and straight irons were put in to strengthen the sand; they also served as a vent for taking away air. When there was a small body of sand covered on three sides with metal the more vent that could be got for it the better.

Incidentally, Mr. Robinson remarked that if moulders could be persuaded to finish off the surface of the mould with a cork rubber or a piece of wood wherever possible there would be much trouble saved. Every time they rubbed with a flat piece of steel the pores of the sand were closed and it was made so that the air could not get through; and wherever the moulder left off a sort of joint was formed between that part and a space which had not been rubbed quite as much. In that space the sand would be porous. When the mould was being cast the air which was generated or expanded by the heat of the metal would find its way through the porous part and get behind the part which was not porous and blow it off. He considered that was the way 50 per cent. of the wasters in a foundry were made.

Discussion.

MR. KEY asked the reason for varying the thickness of the chills. From Mr. Robinson's description the case seemed rather complex. Did he find any ill effects on the top of the jacket core through the metal dropping from the top of the cylinder? If the cylinder was not perfectly vertical the metal was apt to catch the top of the jacket core.

MR. SIMKISS said he considered the elimination of the spongy part was a chemist's job. Nevertheless, he was an advocate of chills and used them considerably. He noticed in one of the slides that the runner was from the top straight down. In his own practice he placed the top runner on the angle and thus got a swirl in the metal, which thus continually changed the position of the scum rising to the surface. He was particularly struck with the variation in the thickness of the chills. It depended on the depth of the machining that had to come off. The chills were not for hardening purposes, but for the elimination of sponginess and a ⅜-in. chill was very effective if not much machining was necessary. But he did not see the necessity for running metal through if the chill was doing its work. He would like to know whether there was any necessity for chilling opposite the valve box. Mr. Robinson had referred to cylinder cracking at the corner of the valve box. His (the speaker's) view was that it was probably caused by the heating up of the metal round the firing box. He had seen in gas engines many a valve face which had cracked badly through overheating.

MR. HILTON asked what was Mr. Robinson's practice with regard to blacking and washing over. Did he believe in agitating the metal in all kinds of castings as a means of eliminating the scum or getting it out of the way? In the case of a green-sand mould, was it desirable to black or not black as a means of getting rid of the scum?

MR. NORRIS asked whether Mr. Robinson had any trouble with the chills when they were used several times. His own experience was that chills ⅜-in. to ½ in. thick blistered or split after being used twice or thrice, and a big hollow place was found in the casting.

MR. ROBINSON, in replying, said the reason for the difference in the thickness of the chills—1¼ in. at the bottom and ⅝ in. underneath the flange—was that the

thicker the chill the more quickly the metal solidified, and the metal in the bottom part of the cylinder was required to solidify quickly, so that it should not draw away from the metal immediately above it. The ⅝-in. chill would strike back sufficiently far to get the metal solid for the amount of machining which was done (the same amount of machining was allowed on the 16-in. as on the 17-in. cylinder) while a thicker chill struck back too far and did not allow the metal up above to come down and feed the part immediately below the flange. The mixture of metal was varied according to the size of the cylinder; for large ones he used a bigger percentage of white iron. Tests were taken practically every day, and very satisfactory results were obtained at present; on four consecutive days the bars stood a tensile test of over 19 tons. The best figure recorded was 19 tons 12 cwts. He never experienced much trouble with respect to the metal cutting the oil-sand core. In this connection he might explain that when he was not using the down-side runner he nailed a thin sheet of iron on to the jacket core just where the metal dropped, to prevent it cutting. Of course the dropping of the metal stirred the scum up and kept it lively, and helped the sand which had been washed off to remain on the top; otherwise it had a chance of sticking lower down the mould.

Continuing, Mr. Robinson said he was much obliged to Mr. Simkins for the suggestion about having the runner at an angle. If the metal came in at an angle it was bound to get a movement, and that movement was bound to break up the scum and help it to rise to the top. The 1¼-in. chills were tried in the first place, but they were found to strike too far back on the flange. On the bottom part, however, the same objection did not arise, and no trouble was caused in machining. Therefore, for that part, the same chills continued to be used, and the results were satisfactory. With respect to the cracking of cylinders, he was still of opinion that this resulted from one part becoming extremely hot and wanting to expand while the other part did not, because all the cylinders they had under consideration cracked in the same place. There were any amount of oils on the market. He used a local product the proportions being one pint of oil to about five or six shovelfuls of sand. Approximately a shovelful of sand measured a gallon. Only sea-sand was used, and it was previously moistened. Sea-sand being practically pure silica had no binding element, consequently it needed something to hold it in the form taken by the core box. After the metal was cast the heat burned out the oil, and as there was nothing to hold the sand together it simply trickled out of the casting. The reason for applying blacking to the face of the mould was to prevent the metal burning on to the face of the sand. There were numerous cases in which it was used, and it was always with the same object—to get a good skin on the casting. For work which was very thick, he had the face of the mould blacked with an ordinary wet charcoal blacking, and afterwards dry plumbago was dusted along. Then it was rubbed over.

The next query was, "Is it better to black a green sand mould or not?" That depended on whether a nice-looking casting was wanted. If the appearance was not important, blacking was not necessary. Then it also depended on the thickness of metal in the casting. If the work was thin his advice was not to black.

A Member asked whether blacking would do away with the cutting action.

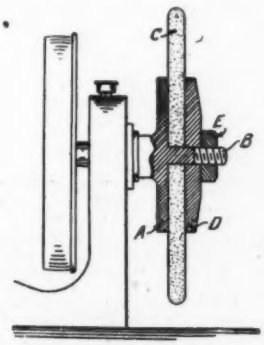
Mr. Robinson replied in the negative. He had not experienced bad effects from using chills a number of times; some had been in service for two years, and more, and he had never had any trouble which could be traced to a faulty chill. It was only necessary to renew them when the fettlers broke them.

A hearty vote of thanks to Mr. Robinson concluded the meeting.

Tool-Grinding Apparatus.

By "Technicus."

Minor necessities are rarely given the amount of consideration they deserve, with the result that productivity is considerably hampered at its outset, and very probably through each stage to completion. This lack of consideration, and incidentally appreciation, is no better exemplified than in the grinding apparatus supplied to the majority of pattern-shops. It usually takes the form of a flat grindstone, this being, apparently, all that is required for grinding the miscellaneous tools comprising a pattern-maker's "kit," tools with an inward, ground curve (and they are many) being obviously not considered. The result of this laxity is that much time is wasted (and with results generally very unsatisfactory) in evolving methods to accomplish that which is after all a very simple operation. These methods vary from turning



up a wood disc and coating its curved edge with emery powder by means of glue to utilising the edges of the flat grindstone, which latter are, usually, by means of an old file, converted to any required curvature.

There are many manufacturers who supply what is more or less an ideal grinding apparatus suitable for every form of tool, and this is accomplished by having attached to a central spindle, and at intervening distances, grinding discs of varying curvatures. For small shops these are, unfortunately, prohibitive in price, and with this in mind the following suggestion, which the author has found eminently satisfactory, is offered.

The plate A (Fig. 1) is made to screw on to the lathe as a face-plate, with the projecting spindle B, which spindle carries the grinding disc C. The latter is clamped firmly against the plate A by means of the plate D, the whole being retained by the nut E. Any sweep of grinding disc can thus be placed on the spindle, which spindle should be sufficiently long to carry discs of varying thickness. Cast-iron or brass is quite suitable for the plates A and D, but the spindle B should preferably be of steel.

Obviously this does not adapt itself to wet grinding, and consequently grinding discs should be ordered up for *dry grinding*. This dry grinding does not affect the temper of the tools, and is certainly cleaner and equally as efficient as the wet stone.

British Foundrymen's Association

Scottish Branch.

A large party of the Scottish Branch of the British Foundrymen's Association on March 8, on the invitation of the Branch President (Mr. Wm. Mayer), paid a visit to Levenbank Foundry, Dumbarton. The members were met at the works by Mr. Mayer, the managing partner of the works, and were conducted during the visit by the various members of the staff.

In the brass foundry, the outstanding features are the brass-reclaiming mill, where all the brass ashes and shop sweepings are treated and the reclaimed brass passed back to the store: also the small air furnaces, where all the brass is melted for the small and medium castings, these furnaces taking the place of the crucible furnaces.

There are four iron foundries at the works, two being specially adapted for large castings (each of these foundries having two overhead cranes of 25 tons lifting capacity), and the other two for the medium and smaller work, also with two overhead cranes of 12 and 10 tons lifting power respectively. In the two shops for large work the moulding pits are all built of cast-iron, with special bolting arrangements for binding the moulds when casting; the arrangement of these pits called forth some favourable comments as to the economy of floor space and orderliness of working. In Fig. 2 is shown one of these pits. The method of drying the moulds in the pits by hot-air furnaces, which has been in use for a number of years, was also closely scrutinised. But more attention was given to the same process of hot-air drying which has been recently installed to all the stoves. Each stove is provided with a small furnace, the blast pipes being laid up to each and supplied from a small fan. The hot air is driven direct into the stoves, the effect of which, as to cleanliness and quick drying, could be easily seen. The other two foundries are splendidly equipped with smaller moulding pits and box parts for the moulding of marine-engine columns, small cylinders, etc., also all the green-sand castings.

The dressing or cleaning shops are situated at the ends of the larger moulding shops, where the castings are passed along, and a railway runs between where they are loaded and despatched when ready. The cleaning shop for the smaller castings is fitted up with a tumbling barrel and grinding buffs, and there is also a large washing and grinding mill for recovering from the cupola slag or dump, cleaning shop rubbish, ladle skimmings and skulls, and all sorts of foundry riddlings. Each cleaning shed is supplied with pneumatic hammers, and the moulding shops with pneumatic rammers.

FIG 2.—OSCILLATING CYLINDER PATTERN IN MOULDING PIT.

In connection with the cupolas and their charging arrangement, a special attraction to the visitors was the new process adopted of charging. Cast-iron boxes are filled with the various mixtures of iron and coke on the ground level and hoisted up into mid-air on a trolley runaway, travelling to the charging door, which is fitted with a chute, when the whole charge is dumped into the cupola. The blast is supplied by a combination fan and motor arranged on the cupola platform.

After the inspection a hearty vote of thanks was accorded Mr. Mayer for his kindness in inviting the visitors to Dumbarton, and for the care taken to show them the features of special interest. Mr. Mayer, in replying, expressed the great pleasure it gave him to have the company present. At the conclusion the visitors were entertained to refreshments at the works.

FIG. 1.—MEMBERS OF THE SCOTTISH BRANCH OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Foundry Sands and Their Treatment.

By Algernon Lewin Curtis, M.E.

(*Continued from page* 215.)

The Relative Value of "Tests" as Applied to Moulding Materials.

Before dealing with the more important tests of moulding sands, it might be of interest to give an illustration of the "cutting over" process of mixing such sands. As this process is the one chiefly in vogue amongst founders, the experiment here described was designed to give an exact reproduction in miniature of "cutting over," with its ultimate results. As stated in previous chapters, to mix or "cut over" sands or sand mixtures even 100 times is not sufficient; though in many cases sands only get cut over once.

For the purpose of demonstration, 5 grains of Malachite green aniline dye in powder was carefully placed on the top of a heap of flour weighing 100 grains. The percentage of dye was in about the same ratio as that when adding clays to an old sand. The following table and illustrations show the results.

In mixing or cutting over these materials, which was done by a spatula on a porcelain slab, "cuts" or movements of the spatula were made from the bottom of the heap towards the top, working in a sequence of four strokes, taking the cardinal points of the compass in rotation, beginning at the North, so that absolute uniform movements of spatula were carried out.

Upon placing the 5 grains of dye on 100 grains of flour the appearance was as in Fig. 1, the dye occupying a solid patch at the apex of the flour heap.

After mixing four times—that is, performing a complete cycle of movements or cuts N.W.S.E. with the spatula—the dye was enclosed in flour.

After mixing eight times, the bulk of the dye was on the West side of the heap, though flour predominated (see Fig. 2).

Mixing 12 times produced a greater distribution of dye, particularly on the North and South sides of the heap, though a strata of flour ran from W. to E. (see Fig. 3).

Mixing 16 times distributed the dye more evenly with the flour, though at the top of the heap dye predominated, and at its base flour. Grains of dye and lumps of flour were also scattered at the base of the heap, which was in general of a dirty salty colour (see Fig. 4).

Mixing 20 times brought further flour towards the centre, and dye predominated N.W. to W.S. (see Fig. 5).

Mixing 24 times gave the material a still dirtier salty colour, and showed a larger proportion of dye from the apex of the heap to the North (see Fig. 6).

Mixing 28 times brought to the surface further grains of dye and lumps of flour, partially burying the patch of dye shown in previous figure (see Fig. 7).

Mixing 32 times showed streaks or strata of dye running from the apex of the heap towards the sides, as shown in side elevation (Fig. 8).

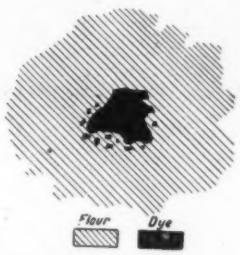


FIG. 1.

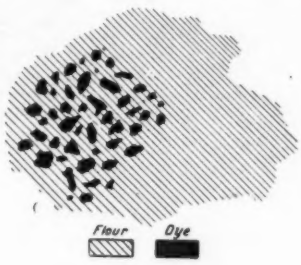


FIG. 2.

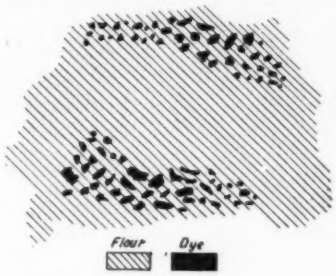


FIG. 3.

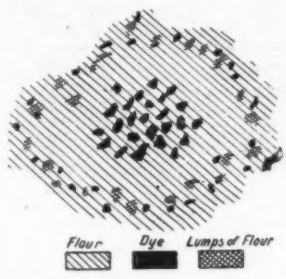


FIG. 4.

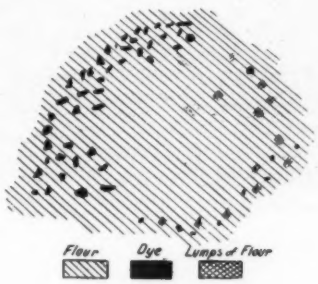


FIG. 5.

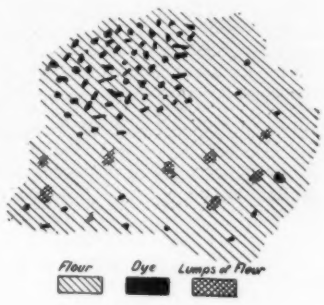


FIG. 6.

Mixing 36 times showed flour to predominate, and the same condition prevailed after mixing 40 and 44 times. After mixing 49 times there was a greater predominance of flour, and after mixing 53 times the dye again began to assert itself. After mixing 58 times particles of dye and lumps of flour were brought to the surface of the heap. In this condition the material would have remained unless put under pressure. Accordingly it was rolled out flat on the porcelain plate (see Fig. 9).

The flattened mass was then mixed 16 times more —in all 74 times—and showed lumps of both dye and flour which were not incorporated. After mix-

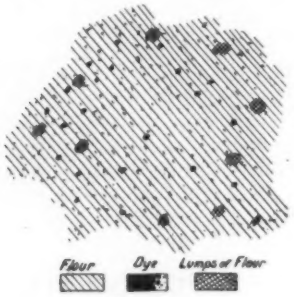


FIG. 7.

ing 90 times dye was still shown to be in patches; and mixing 110 times showed flour to predominate. After mixing 160 times the materials began to exhibit signs of incorporation. After rolling flat a second time on the porcelain plate, the condition of the material was as seen in Fig. 10. It should be noticed that the amount of lumps of flour and grains of dye is considerably smaller in Fig. 10 than in Fig. 9. This is due to extra mixing.

By mixing 210 times, or 50 times more than the previous mixture, the dye began to assert its colour, showing stronger signs of incorporation with

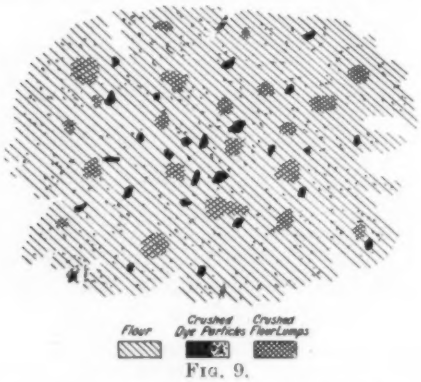


FIG. 9.

the flour, and after rolling out a third time was as shown in Fig. 11. It will be noticed that only a few lumps of either flour or dye remained in the mass. The result, after mixing 310 times, or a further 100 times, and rolling a fourth time, is seen in Fig. 12. No patches of flour or lumps of dye were visible. After applying water with a camel-hair brush to the surface of Fig. 12, the appearance to the naked eye was as in Fig. 13. The dark spots represent grains of dye of a very dark blue colour, the fine shaded portion being a matrix of flour of a light green colour.

From the above simple experiment, which is quite analogous to the problem of mixing clay or different sands, compounds, coal or coke dust, etc., to other sands, it will be easily seen how futile is the cutting-over process when carried out on the lines usually adopted in foundries. No further evidence than that contained in the foregoing illustrations should be necessary to show the difficulty of mixing or incorporating any two materials together; and where clay is one of the ingredients used greater difficulty will be experienced in mixing than with a dry material like dye, because the former has to be squeezed into particles of quartz or felspar, so that a film of clay substance exists between each.

Before adopting tests of moulding materials, whether chemical or physical, the main thing to be observed is the condition such materials are in when being tested. In other words, it is useless to select

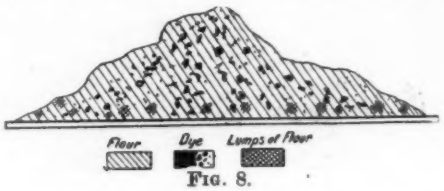


FIG. 8.

for tests samples of sands that will be doctored by clay-wash, molasses solution, compounds, or water, before the moulder actually puts these into a mould. Even a sample of sand sent through the post gives no indication of the state in which it is used. Such samples can, however, be analysed chemically, though, perhaps, these analyses may not avail if the trouble is caused by the kaolinite in a sand being ruined through an excess of water, or *vice versa*, which condition the chemist is not acquainted with, owing to evaporation of water during transit. Therefore tests or apparatus for conducting same should be sufficiently sensitive to deal with the material as it is actually used.

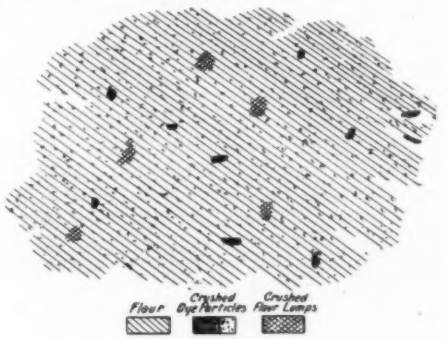


FIG. 10.

To make good moulds or cores it is absolutely necessary to use a good moulding material (70 per cent. of old sand is a good ingredient, if of the right base), which cannot be obtained unless the ingredients are mechanically and efficiently treated. The chief features of such a moulding material (which cannot altogether be termed sand, as a "mixture" contains a number of other ingredients besides sand), may be classified in their respective order, thus:—

(*a*) Size of the quartz or felspar particles in a sand.

(*b*) The fusing point of same. (This depends upon amount of foreign substances, such as iron oxide, etc., which act as fluxes).

(*c*) Strength of mixture (with this are associated permeability, porosity, binding power and capillary action).

Regarding the size of quartz or felspar particles, it may be stated that artificial sand mixtures, now in extensive use in Belgium, Germany and America, demand definite sized particles for different classes of work. In most cases in England sands with varying sized particles and clay contents are used. Every sand, however, whether natural or artificial, should possess a low dust factor, *i.e.*, the smallest amount of fine particles. For example, if a sand is required for a particular class of work and demands a size of particle that will pass a 100-mesh, but be retained on a 150, then particles which pass the 150 sieve are detrimental to the mixture. With such particles that pass through a 150-mesh will be much of the sand's aluminous matter, which will be lost and should therefore be made up by an admixture of suitable clay during mechanical treatment.

It may be argued that sifting out fine quartz, felspar and clay particles from a sand, then introducing fresh clay into the same sand is a foolish procedure, as in the fresh clay introduced are many

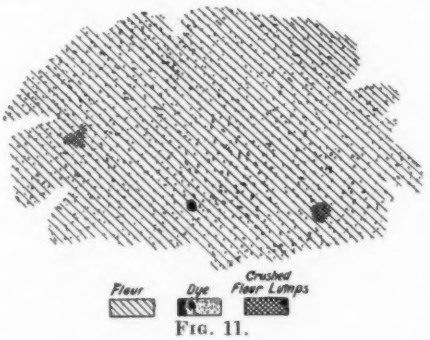


FIG. 11.

small particles of free silica. Such an argument might hold good if a clay containing over 50 per cent. of free silica were used (except in certain cases), but if a sand between 100 and 150-mesh is required it will show from 15 to 25 per cent. of particles that will pass through a 200-mesh sieve, representing dust. All this is not clay—perhaps up to 5 per cent. may be; the remainder is quartz or felspar particles too small for use, and the dust particles of free silica in the clay introduced would not exceed 2½ per cent., as compared with anything up to 25 per cent in the original sand.

Therefore, if a sand of uniform size is required for a certain work (uniformity being 60 per cent. and upwards of the same sized particles), in order to establish a maximum percentage of correct sized particles, the material should be sieved, and during such operation much of the sand's clay will be lost. New clay must then be introduced into the sand by mechanical treatment, the amount being determined by first ascertaining by chemical analysis the amount of clay left in the original sand after sifting, then sampling the mixture as it comes from the machine during the treatment, and finally adjusting the clay content to the work.

To test the size of quartz or felspar particles in a sand, several methods, more or less complicated, have been suggested, particulars of which are given below. After carefully studying most of the different methods for carrying out such tests, the author has (taking into consideration the general conditions under which such tests would be made and the more or less difficult and complicated task of working those out), come to the conclusion that instead of using a series of figures to represent the "degree of fineness" or "surface factor" of a given sand, it would be easier and better understood if such a degree of fineness were expressed in the natural way, by simple figures, as represented by the percentage of particles which will lie on par-

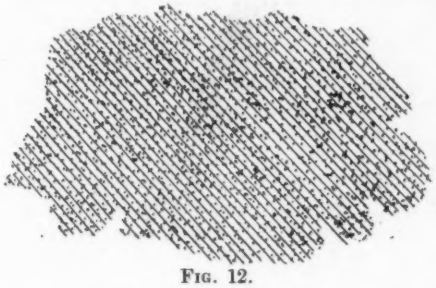


FIG. 12.

ticular sized sieves. For general commercial use the sieves may be in units or sizes of 25, beginning with 50 and going up to 200, thus :—50, 75, 100, 125, 150, 175, and 200. In analytical work, however, sieves with units of 10 are desirable. The results of such a test can then be written in a simple manner, easily understood by everybody.

Test of Fineness of 100 *Grammes of Mansfield Sand.*

Size of sieve.	Amount (percentage) in grammes.
50 mesh	10 grammes
75 ,,	20 ,,
100 ,,	40 ,,
125 ,,	14 ,,
150 ,,	10 ,,
200 ,,	6 ,,

It is understood that large lumps are crushed, but the sand should not be ground.

Such a result may not look as simple a factor of fineness as "55.05," but when the details of other

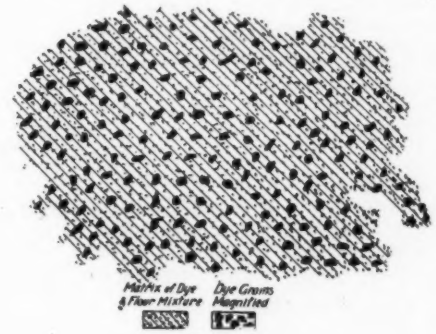


FIG. 13.

tests are examined the above would appear to be simpler and at the same time convey at first sight a useful description of the size of sand.

The *modus operandi* in conducting the above test is to first dry a sample of sand at 212 Fah. for one hour, then carefully weigh out 100 grammes, finally putting it into sieve 50, which should be the top section of a nest of sieves. The nest being provided with a top and bottom, agitation can take place without spilling any of the sample. Agitation

may be considerably accelerated by using four ½-in. diam. steel balls, which assist by giving a centrifugal motion to the whole sieve cylinder, and an equal momentum thereby obtained. A horizontal elliptical movement from left to right, with a path diameter of from 12 in. to 18 in., is the best form of shaking; and in most cases 250 to 500 revolutions are necessary to completely sieve all the material. After sieving, each section is removed and the contents and the weights carefully recorded in grammes, results being expressed as previously shown. For more accurate work the sieve sections should be in units of 10 instead of 25.

Below is given Scott's method of testing fineness, together with Mather's improvements in same. The "mean surface factor" or degree of fineness according to Scott is when—

W. = Total weight of sand.

N. = Total number of grains.

V. = Mean volume of grains.

Scott assumes that the specific gravities of all the grains of sand are equal, being represented by S, and the grains are spherical in shape. Here it may be noted that the specific gravities of the ingredients in a sand are of a very varying nature, as seen from the following :—

Specific gravity of quartz = 2.0 to 2.80.

Specific gravity of clays = 1.7 to 2.6.

Specific gravity of felspars = 2.0 to 3.0.

Also, when assuming sand particles to be spherical, this should only apply to core sands, as a sand possessing round particles is not always used for making moulds. These differences may have an important bearing on the ultimate results of such a method of testing a sand's fineness.

From the following then—W = N.S.V.

Let the sieving divide the sand into grains of volume, V_1, V_2.....Vn.

Let the number of grains of each size be N_1, N_2.....Nn.

Let the weight of the above number in each section be W_1, W_2.....Wn.

Then $W = W_1 + W_2 + \ldots\ldots + W_2 = N, \quad SV_1 + N_2SV_2 + \ldots\ldots + N_2SV_n$.

And $\frac{1}{V_1}$ is a direct function of the mean fineness of the particles in that section, which can be expressed by the number of mesh of the sieve.

$$\text{Th n } \frac{1}{V} = \frac{NS}{W} = \frac{S\,(N_1 + N_2 \div \ldots\ldots N_2)}{W}$$

$$= \frac{SN_1 - SN_2 \div \ldots\ldots SN_2}{W}$$

$$= \frac{\frac{W_1}{V_1} + \frac{W_2}{V_2} \div \ldots\ldots \frac{W_n}{V_2}}{W}$$

Now $\frac{W_1}{V_1} = W_1 \frac{1}{V} = W_1 \times$ number of mesh of 1st sieve × constant;

$\frac{W_2}{V_2} = W_2 \frac{1}{V_2} = W_2 \times$ number of mesh of the 2nd sieve × constant;

$\frac{W_n}{V_2} = W_n \frac{1}{V_2} = W_2 \times$ number of mesh of the "nth" sieve × constant.

Therefore $\frac{1}{V}$, which is a direct function of the mean fineness, is the result obtained by multiplying the weight of sand from each sieve by the mesh of the sieve, and dividing the sum of these products by the total weight of sand taken. Mather states that as the fineness of the sand which has passed through a sieve is obviously higher than the mesh of the sieve itself, a modification is necessary, and proposes using the mean mesh of the two sieves rather than the mesh of the sieve the sand has passed through, *i.e.*, the weight of sand which has passed through the 20-mesh and is detained by the 40-mesh should be multiplied by 30 and not 20. Below is shown the methods of both Scott and Mather :—

	Weight of sand.	Scott's Method.	Mather's Method.
Not through 20 mesh	5 grains	5× 1= 5	5× 10= 50
Through 20 mesh, not 40 mesh	25 ,,	25× 20= 500	25× 30= 750
Through 40 mesh, not 50 mesh	10 ,,	10× 40= 400	10× 50= 500
Through 60 mesh, not 80 mesh	30 ,,	30× 60=1,800	30× 70=2,100
Through 80 mesh, not 100 mesh	10 ,,	10× 80= 800	10× 90= 900
Through 100 mesh ...	20 ,,	20×100=2,000	20×120=2,400
	100 ,,	5,505	6,700

Fineness factor, "Scott's" Method, $= \frac{5\,505}{100} = 55.05$;

Fineness factor, "Mather's" Method, $= \frac{6,700}{100} = 67.00$.

"Le Chatelier" evidently pursued an original course when attempting to define the "surface factor" or mean fineness of a sand, by what he termed a wet method, though the apparatus he used was scarcely effective enough to compensate him for his labour His method was to place a given number of samples separately in a Schoene's levigating apparatus, and determine the following :—

(*a*) *Impalpable.*—That which was carried away by a vertical stream of water ascending at the rate of 1 mm. per minute.

(*b*) *Fine.*—That which would pass a mesh of 0.1 mm. (approx. 250 per inch) after (*a*) had been removed.

(*c*) *Medium.*—That part of the residue which would pass a mesh of 1 mm. (approx. 24-25 per inch).

(*d*) *Coarse.*—All the residue after (*c*).

Such a test as Le Chatelier's is, of course, exceedingly useful for chemical investigation, though hardly lends itself to foundry use at present.

Ries, who carried out a number of experiments, was certainly on the right track in trying to artificially disintegrate (by shaking in water for a long period), the cohesive clay from quartz grains, then passing same through standard sieves, and noting amounts and sizes. Until the washing of sands becomes more popular, however, this latter test will not be extensively used, though the author might state that it will not be very long before the washing of sands in certain foundries previous to using is extensively carried out, as even now in the State of Michigan, U.S.A., several washing plants are being worked with exceedingly successful results.

(To be continued.)

British Foundrymen's Excursion.

The Council of the Birmingham Branch of the British Foundrymen's Association has arranged for the annual excursion of the members to take place on Saturday, June 10. The party will leave Snow Hill Station, Birmingham, by train at 1.25 p.m. for Stourpourt, and will travel thence by steamer down the River Severn to Worcester Cathedral, returning to Birmingham at night by train.

The Microscope in the Foundry.

Before the London Branch of the British Foundrymen's Association on April 12, Mr. George Hailstone, of Birmingham, gave an illustrated address on "The Application of the Microscope in the Foundry." Mr. J. W. Horne, B.Sc., Assoc.Inst.C.E., occupied the chair.

The text of the lecture was published in our issue of March, 1911, but may be briefly surveyed here, as follows:—

It may be said by some that the microscopic examination of pig-iron is simply a more refined way of examining the fracture, but this is not so. A fracture reveals only the appearance after breaking by a force, such as a blow, and even the nature of the blow used to effect fracture has a considerable influence on the appearance of that fracture. In breaking a pig of iron the greater portion of the fracture follows the plates of graphite, and, as a result, the broken surface may show a preponderance of graphite inconsistent with the actual composition of the pig. The microscopical structure shows the actual relation that exists between the various constituents contained in the iron, and therefore may be termed the internal architecture.

The samples are either cut in a saw or lathe, or by filing in a vice, or other means, to a suitable size, a convenient section being about 0.5 in. diameter and 0.1 in. thick. The face of the section to be examined is filed flat with a dead-smooth file, and the edges slightly bevelled to prevent injuring the polishing pads in the subsequent operations. When all the file marks are in the same direction the specimen may be polished by hand or machine. The section is rubbed at right angles to the file marks on a piece of FF emery cloth that has been stretched upon a piece of smooth, hard wood, and when all the marks made by the FF emery cloth are in the same direction, and the whole of the file marks have been removed, the section is reversed and rubbed on O emery cloth, and this process is continued on O, OO, OOO, and OOOO emery papers, reversing the section each time the paper is changed. The section of iron is then rubbed, at right angles to the scratches, on a piece of wash leather, covered with the finest rouge, stretched on a piece of wood, until the section is free from scratches.

When the section is free from scratches it will be noticed that the surface is discoloured or tarnished, due to high local temperatures being produced between the metal and the polishing pad. To remove this colouring, the specimen is rubbed a few times upon a rouged pad which is kept well moistened by alcohol. The specimen is then wiped dry by means of a piece of old soft linen, after which it is ready to be examined to determine the size of the graphite, and then to be etched.

[After describing some mechanical polishing apparatus, Mr. Hailston expressed a preference for hand polishing for the finishing, as the fine regulation of pressure required could not well be got by mechanical means. He next proceeded to describe the microscope and the means of illuminating the specimen.]

After the polished section of cast-iron has been examined to determine the size of the graphite, it may be treated with suitable chemical reagents to reveal the various constituents present. One of the most useful reagents for this purpose is tincture of iodine. This is applied to the section by successive touches of a drop conveyed by the finger, the drop of solution being allowed to remain on the specimen until it is completely decolourised, when it is examined, a further addition being added if needed. After etching the specimens are washed in alcohol and wiped with a piece of fine dry linen. Another reagent that gives good results with cast-iron is a 5 per cent. solution of sulphurous acid in water. The solution is placed in a small dish and the specimen immersed in the solution for a minute or so, this operation being repeated until the metal is sufficiently etched.

The micro-constituents that are usually found in normally-cooled commercial grey foundry irons are:—Ferrite, cementite, pearlite, phosphide of iron (which when cementite is present forms an eutectic) and manganese sulphide. The formation and amount of these constituents, however, depend upon the amount of silicon, sulphur, phosphorus, manganese, and on other factors, such as casting temperature and rate of cooling.

Ferrite is pure iron; sometimes it occurs in crystals that are readily recognised, but more often than not as a white groundwork or matrix. Being unstained by the etching liquid that is used to reveal the various constituents, it remains white. Silicon and manganese are present among the ferrite, and as they are isomorphous with the iron, they often replace some of the crystals of ferrite. Ferrite is the softest constitutent of cast-iron, excepting graphite.

Silicon exists in cast-iron as a silicide of iron, but this silicide is in solution in the iron, forming crystals of the cubic system. The crystals of silico-ferrite are of a pale yellow colour, and the ordinary ferrite white. Cementite is the carbide of iron containing 6.6 per cent. of carbon. It is a vexed question as to whether cementite is a chemical compound or not in foundry irons. It is most probable that in a pure iron-carbon alloy the pure carbide corresponding to the formula Fe_3C is present. Sometimes the iron is replaced in cementite by manganese, which itself forms a true chemical compound with carbon, when double carbides of iron and manganese result. Cementite is the hardest constituent of cast-iron. It resembles ferrite inasmuch as it is not stained by the etching liquid, but being very hard it stands up in relief after polishing, and is, therefore, readily distinguished.

Pearlite is a definite mixture of ferrite and cementite, containing about 0.89 per cent. of carbon. The carbon in pearlite is molecularly associated with only 12 per cent. of the iron, 87 per cent. of the latter being in the free state. Pearlite is coloured dark by the etching liquid.

Graphite occurs in cast-iron in varying-sized flakes, from very small to very large. The phosphorus compound associated with cementite forms an eutectic, and is characterised by the form it takes, like a numbers of streaks and dots. This phosphorus compound contains about 2 per cent. of carbon and 6.7 per cent. of phosphorus. When present in cast-iron containing no cementite, the phosphorus occurs as phosphide of iron, corresponding to the chemical formula, Fe_3P, and is a hard, white, structureless constituent similar to cementite, but softer.

Manganese sulphide occurs in square or oblong-shaped crystals of a dove-gray colour, when the manganese sulphide is pure, but often in cast-iron it is found that iron sulphide and manganese silicate have crystallised out among the crystals or areas of man-

ganese sulphide, when light yellow crystals or deep blue-coloured crystals respectively in the dove grey ground-work are got.

The manganese sulphide sometimes occurs in the cementite, and sometimes in the pearlite, according to the amount of sulphur present in the cast-iron. The writer has observed that when the sulphur in cast-iron is below 0.11 per cent. the manganese sulphide is always found in the carbide of iron or cementite, but when the sulphur is above 0.11 per cent., some manganese sulphide is found in the pearlite. Manganese sulphide thus appears to be soluble in cast-iron to a limited extent, and 0.11 per cent. of sulphur in cast-iron containing manganese, which equals 0.3 per cent. of manganese sulphide, appears to be the saturation limit of cast-iron for manganese sulphide.

To prepare and etch a specimen of cast-iron for the purpose of obtaining the condition and approximate amount of phosphorus present in the specimen, it is not necessary to highly polish the metal surface. After polishing on fine emery paper the specimen is immersed in a 20 per cent. solution of nitric acid in water for two or three minutes, then washed with water and dried, when it can at once be examined. Etching polished sections of cast-iron with chemical reagents is more or less liable to lead to the confusing of the constitutional and crystalline structures. With very feeble etching, as a rule, the different constituents are made visible; with long continued etching the granular and crystalline structures are developed.

By heating polished and unetched sections of cast-iron till they assume certain oxidation tints, the various constituents are coloured differently. This colouring is due to the formation of oxidation films, which form at different rates on the different constituents. Heat-tinting does not usually give any indication of the crystalline structure, but stands far before all other methods as a means of detecting the individual constituents. When a section of cast-iron is treated in this way and heated until it becomes purple in colour to the naked eye, when examined under the microscope it will be seen that the various constituents are diversely coloured, the ferrite being a fine sky blue, the carbides of iron an orange colour, the phosphides a pale lemon yellow, and the sulphides a slaty blue.

Discussion.

The CHAIRMAN, in opening the discussion, remarked that with the aid of the microscope very much better results could be got in the foundry.

MR. BOOTE said that not only was it not easy for the layman to detect the different constituents, but even experts frequently hesitated to express an opinion on the constituents of a strange section. It was very desirable that in research work the same magnification should be employed for micrographs, as the same section looked entirely different under a different magnification.

MR. D. GORDON asked whether the lecturer condemned altogether machinery for preparing specimens. He (Mr. Gordon) thought that much time could be saved by roughing the specimen on the lathe.

MR. HAILSTONE, replying, said that though the microscope would not cure all foundry ills, it might be used as a valuable test in discovering the nature of some of those ills. Regarding Mr. Boote's remarks on the expert, it must be remembered that, like the doctor, the expert desired all the available information on the case before diagnosing the complaint. He did not condemn machinery for roughing the specimen, but considered that machines were not so delicate as the hand for finishing.

International Exhibitions.

The Report of His Majesty's Commissioners for the International Exhibitions at Brussels, Rome and Turin, 1910-11, published recently, is of considerable interest in view of the work which is being done at the present time by the Exhibitions Branch of the Board of Trade in connection with the International Exhibition at Ghent.

The sum total of the various Parliamentary grants in connection with these exhibitions amounted to £211,400, but of this sum £63,000 was spent by the Board of Trade in the purchase of permanent plant. A part of this plant was destroyed in the fire at the Brussels Exhibition, but the remainder, which represents approximately £27,600, is available for use at future exhibitions. It may be interesting to compare this grant with the expenditure incurred in connection with former universal exhibitions. The cost of the British Section at the Paris Exhibition of 1900 amounted to £97,033, while that at St. Louis in 1904 involved an expenditure of £128,000. It is to be noted that these amounts relate to only one exhibition in each case, whereas the total grant of £211,400 for the Brussels. Rome, and Turin Exhibitions covered the cost of organising four distinct British Sections, viz., two at Brussels, one at Rome, and one at Turin, besides the purchase of permanent plant.

These were the first international exhibitions in which this country has taken part officially since the formation of the Exhibitions Branch of the Board of Trade. The Committee appointed by the Board of Trade in October, 1906, to inquire as to the nature and extent of the benefit accruing to British industries from the participation of this country in great international exhibitions, considered it essential that an efficient permanent organisation should be created to act on behalf of British exhibitors in all negotiations with foreign exhibition committees, Customs officials &c., &c., and to render them such assistance as would enable them to show their goods effectively at international exhibitions abroad without a prohibitive amount of trouble and expense. In accordance with this recommendation of the Committee, the Exhibitions Branch of the Board of Trade, under the direction of Mr. U. F. Wintour, was formed in 1908 to deal with all questions relating to the participation of this country in international exhibitions abroad.

One of the principal reasons of the establishment of the Exhibitions Branch of the Board of Trade was to avoid the delay which in the past had usually taken place in the establishment of any organisation to deal with British interests at each exhibition.

In order to relieve exhibitors of as much trouble and expense as possible, as well as to give a distinctive and uniform appearance to the British Section in these Exhibitions, it was decided at the outset to provide without further charge beyond that made for space occupied, all showcases, stands, platforms, railings or screens that might be required by exhibitors for the display of their goods. By this means one of the principal items of expense to British exhibitors in the past was entirely eliminated and in its stead the exhibitors were called upon to pay only a small charge for the space occupied. Having paid this initial charge British exhibitors were accorded, without additional cost, a number of facilities which reduced still further the heavy expenditure incurred in past exhibitions. The Exhibitions Branch took delivery at the exhibition gates of all packages containing exhibits, unloaded them from the railway trucks, and placed them on the space allotted to the exhibitor. To facilitate the installation of heavy

exhibits such as machinery, overhead cranes were provided, free of cost, for lifting them into position, and with a view to encouraging the exhibition of machinery in motion it was decided to defray 50 per cent. of the charges made by the Belgian Administration for the supply of steam, gas and electricity.

Value of the Exhibitions.

In order to ascertain as far as practicable what commercial results had accrued to British exhibitors from participation in the Brussels and Turin Exhibitions, the following questions were submitted to all British exhibitors:

(1) Have you had, up to the present time, any development in your business which you can attribute directly or indirectly to the exhibition of your goods at Brussels (or Turin)?

(2) If so, can you give any information as to the extent or value of such development?

(3) Have the sales effected as a result of the exhibition of your goods at Brussels (or Turin) repaid you for the cost of exhibiting?

(4) Have you any observations to make with regard to any improvement which might be made in the organisation of British exhibits at future Exhibitions?

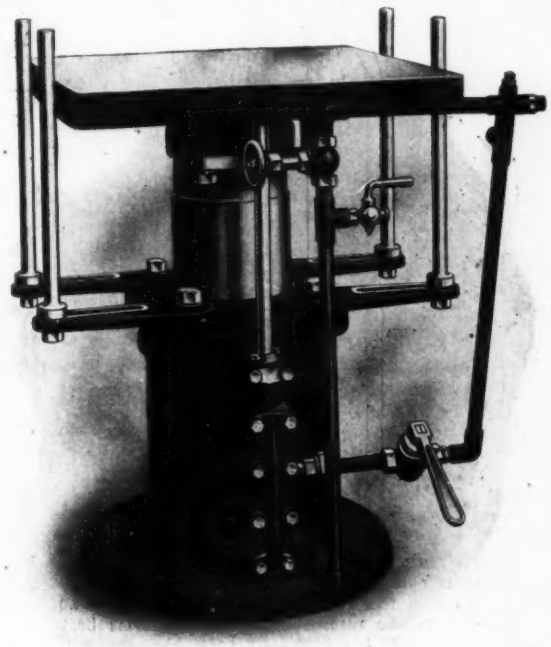
The answers received were, on the whole, of a very satisfactory character. In the case of the Brussels Exhibition 32 per cent. of the exhibitors stated that their exhibits had produced good tangible results, a highly satisfactory percentage considering the difficulty of estimating the results of exhibiting. A further 33 per cent. of the exhibitors indicated that they were satisfied with the result of their exhibits, making a total of 65 per cent. who felt that their expenditure upon this form of advertising had not been misplaced. Of the remaining 35 per cent. the great majority simply answered the questions in the negative, and while it is clear that these exhibitors could not have any direct benefits, it is, on the other hand, scarcely fair to assume that their expendiutre has been wasted.

Ghent Exhibition.

The British Section at the International Exhibition at Ghent is housed in a pavilion, which is a large low building approximately 130 yards square, divided into a Machinery Hall and four surrounding galleries. The industries of Ghent are very largely textile weaving and the manufacture of machinery, and have earned for the town the title of "The Manchester of Belgium." These considerations have caused the Board of Trade to select machinery as the central feature of the British display. Practically every type of machine used for spinning and weaving will be shown at work. Among other machinery exhibits are a power planer for iron and steel, weighing 25 tons, and powerful drills for boring boiler plates, etc. Very interesting displays are also made by several great English railways, notably by the Great Central Railway. The exhibit of the National Physical Laboratory illustrates the work done by that Department in elucidating the problems of flight. The exhibit of trade and technical journals is shown in a library opening out of the Arts and Crafts Section, and specially designed and decorated by Mr. Frank Brangwyn, A.R.A.

"Britannia" Jar-Ram Moulding Machine.

We illustrate herewith the latest jar-ram moulding machine (Daimler Company & Wardle's patent). This is being put on the market by the well-known firm of moulding machine makers, the Britannia Foundry Company, and every part is made at their works at Coventry (London representatives and show room, Murphy, Stedman & Company, Limited, 180, Gray's Inn Road, W.C.). The feature of first importance in this machine is its simplicity of design, and the consequent freedom from parts than can get out of order. Its self-contained lifting apparatus is quite unique.



THE "BRITANNIA" JAR-RAM MOULDING MACHINE.

It consists of an annular piston guided inside and out on the whole of its area, thus giving a large bearing surface, ensuring a perfectly vertical and accurate lift calculated to stand long and hard wear.

The capacity of this machine is very considerable; it will ram any mould up to 10 cwts., and in its duplex form will ram two small boxes at the same time, while an output up to 125 complete moulds per 10-hour day can be attained on some classes of work. A turnover table can easily be fitted if required, but as the machine rams boxes with bars across them to support the sand, the turn-over is not so often a necessity as with the ram-head type of machine.

This machine, although quite new on the market, is anything but an experiment; it was patented in 1911, and since then 25 machines have daily been doing efficient service in the largest automobile foundry in this country. At the present time the Britannia Foundry Company are showing one of these machines at work at the national Trades Exhibition at Bingley Hall, Birmingham.

Making Large Hydraulic Rams and Cylinders.

By Sidney G. Smith.

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Although these castings are as a rule plain in design, it is absolutely necessary that they should be sound, uniform in hardness, and made of close-grained, tough, dense iron; and to fulfil these conditions in producing a sound, solid casting, there

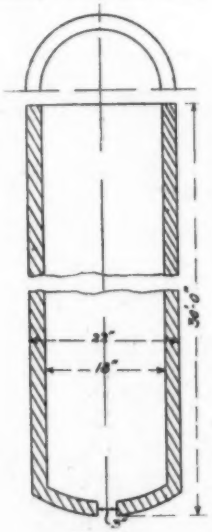


FIG. 1.

must be some compressive action when the iron is in a liquid state in the mould, to give that solidity at the top end of the ram. Uniform hardness is best attained when they are vertically cast.

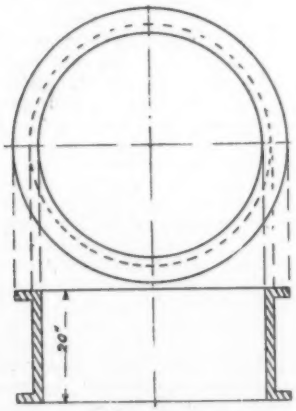


FIG. 3.

A close-grained, dense iron will be low in carbon, say 3 per cent., silicon and manganese and phosphorus not more than 1 per cent. each, the sulphur being as low as compatable with such a mixture. The combined and graphitic carbon will arrange their own percentages in iron of this composition, especially when the section, which is mostly uniform in these castings, is considered. The above mixture is based upon a 2-inch section.

The writer is aware than an iron of different composition may be satisfactory, but what is aimed at in the above is density without excessive hardness

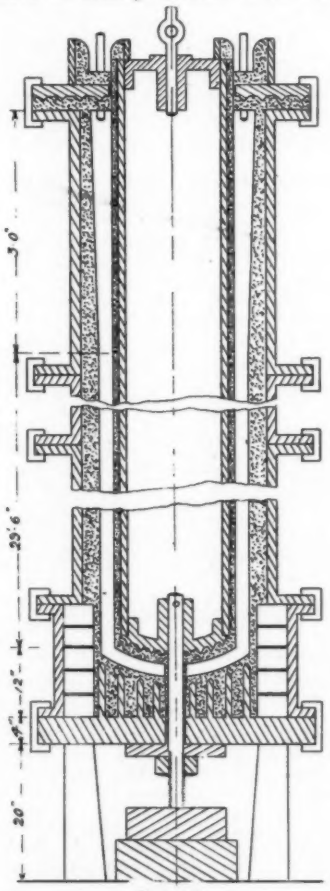


FIG. 2.

in a two-inch thickness, obtained without artificial means; and low total carbon is perhaps most important in this case.

Many small cylinders may be successfully made and cast in a horizontal position, and it is sometimes more convenient to so cast them, especially if large brackets or other projections are attached for fixing to cranes, stanchions, etc.; but under such circumstances large and deep feeders and risers are

needed to make the heavy parts sound and clean; if this is not done, trouble may be expected when the castings are tested.

In the following procedure the ram, which is 30 feet long, 22 inches outside diameter, and 2 inches thick, is moulded and poured vertically in dry sand. Fig. 1 shows in section the ram to be made. Fig. 2 is a section of the mould, boxes, etc., in the pit when ready for pouring. Fig. 3 shows plan and section of the bottom box; Fig 4 the section of the core barrel; Fig. 5 the body pattern; Fig. 6 the bottom plate; and Fig 7 the top cake plate with runner holes; while in Fig 8 the bottom box and plate with striking board set are depicted, showing one side finished off.

The method of moulding is simple, but with a casting of the length of that under discussion, precautions for safety must not be overlooked. The boxes must be strong and well cramped, especially longitudinally, as the bursting pressure at the lower end

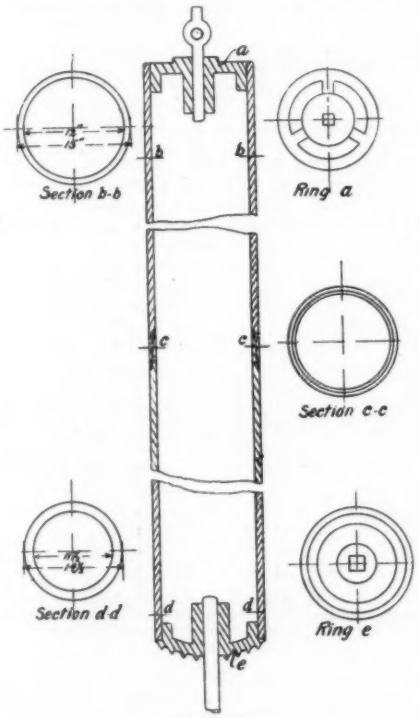


Fig. 4.

of the casting is very great. A deep, dry pit is absolutely essential for this class of work, and it should be of such width that the men can get around the outside of the boxes.

For convenience the pouring basin should not be more than six feet above the floor level, which would mean that when the depth of the feeding head, the bottom box, plate, etc., and packing are taken into consideration, the required depth of the pit will not be less than 30 feet. The core barrel should be 34 feet long and in one length (see Fig. 4). It is not safe to attempt placing the core in the mould in two lengths, for no studs or chaplets may be used to steady the lower lengths of core.

In order to set a core of this length, when the top of the box is five feet above floor level, considerable height will have to be reached, which is generally overcome by fixing a pulley block over the pit sufficiently high to do this. Of course the same pulley block afterwards draws the core barrel when in the vertical position before stripping the casting.

The feeding head in this casting should not be less than 3 feet long, and larger at the top than at the root, which should not be less in thickness than the casting. Feeding rods should be used to ensure soundness. About 2½ inches of sand should be allowed for ramming, and the sand should be of good

Fig. 5.

strength; and to obtain a casting that will strip with a clean skin, the sand should be strongest at the bottom half of the mould. Also the blacking should be of the best quality, *i.e.*, plumbago.

The core barrel is made in two lengths and spliced together. At the bottom end the journal is

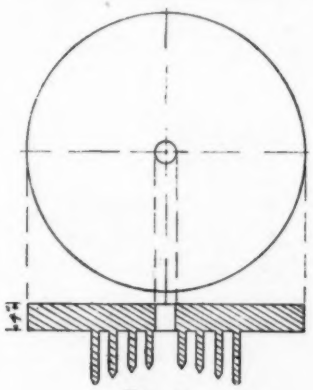


Fig. 6.

threaded to hold the core down by means of washer and nut, screwed up to the bottom plate when the core is set in position, as there is considerable lift from the almost blank end of the core; and it is the best practice with long cores of this description, when possible and practicable, to anchor the core from the bottom instead of packing it down from the top, for by so doing the barrel is allowed freedom for expansion lengthwise, which expansion is considerable

in this length owing to the heat imparted from the casting. There are other ways of doing this, but perhaps the one shown in Fig. 2 is as simple as any.

When the core is lowered to its right position, and held there, the washer and nut are put on. An iron packing is placed under the journal, which takes the weight of the core, which is now centred at the top and held central by stalk chaplets near the top of the feeding head. These chaplets must be placed clear of the runner gates and feeders. The nut is now screwed up tight, after which the cake plate with the runner gates is lowered over the core and cramped, which still further helps to keep the core central. The length of the bottom journal and

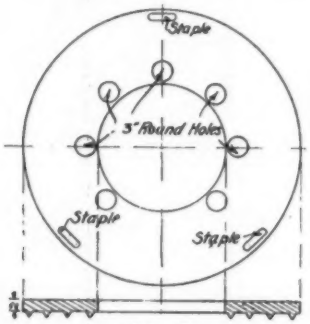


Fig. 7.

threaded part must be determined before it is fixed to the barrel.

The pattern (Fig. 5) which may be of wood or iron (the latter is preferable) need not be longer than 8 feet; 5 or 6 feet may be drawn each time as the ramming proceeds. The pairs of boxes may be of various lengths to make up the total length over all, providing the diameter and provision for cramping are right. Parting joints can be made where necessary for convenience and finishing, blackwashing and drying, but provision must be made for resetting. The ramming must be hard and regular.

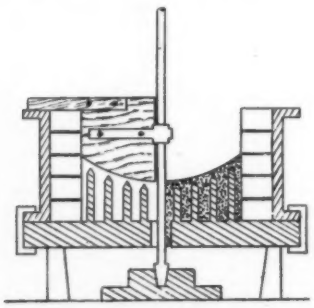


Fig. 8.

The bottom box (Fig. 8) is cramped to the bottom plate, which is prodded. The outside is bricked and swept up with strong loam to withstand the great fall, beat and bite of the iron which occurs in pouring such a deep casting. The loam will still further resist these effects if a little gas tar is added to the fine loam when finishing off.

The above method also applies to cylinders, and should turn out satisfactory castings, providing the mixture of iron is of the right quality. The writer has made rams of rather smaller diameter than the above 22 ft. long, by 2½ thick, and cast them in the flat or horizontal position; but to obtain a sound and uniform texture of iron, the top half of the mould was taken out of the round to the eccentric shape, which entailed a much longer time in machining the casting, but the method was necessary in order to remove what invariably occurs in cast iron of heavy section, namely, a top side soft in comparison with the bottom side.

When a deep pit is not available, another plan is to pour the castings on a declivity, but it is obvious that neither of the latter methods can be compared with that of pouring vertically, when uniformity of hardness is desired. Also, any other position than a vertical one requires studs or chaplets to keep the body core central, and these are very objectionable, owing to their liability to cut or wear the gland packing.

Mandrel for Brass Casting.

By J. Lumsden.

The casting of brass with a mandrel in place of a core in the mould is being more extensively practised now than formerly, on account of the time saved in the dressing of the casting, where a small core may be severely burned into it. The method offers the decided advantages of ease in removing the mandrel and a clean core hole. The greatest care, however, must be taken in making a casting with a mandrel.

The following is a description of a brass plunger 2 ft. long, 2 in. thick, with a ½-in. mandrel through it. The mould was made in the ordinary way with a branch gate on the bottom half of the mould only, with four open risers, as shown in the sketch, to get a good solid casting, as it is necessary to allow the gases which rise from the mandrel to

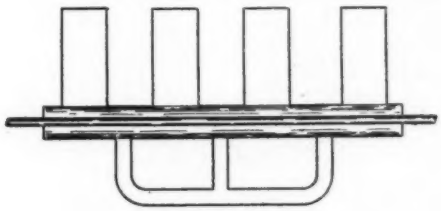


Fig. 1.

escape quickly. The mandrel, a ½-in. steel rod, must not have a smooth surface, as it has to be coated over with a paint composed of plumbago and thick clay water, so it is advisable to give it a rub with a file, as otherwise the paint would not adhere properly to the surface. When the mandrel is thoroughly coated over it should be covered carefully with parting sand to assist in withdrawing it. It must be thoroughly dried and have a good heat in it when commencing to pour the metal. It is advisable that the metal should not be too hot.

The chief source of trouble in a job of this description is getting the mandrel out easily, so instead of allowing the casting to cool in the ordinary way it should be dipped into water immediately it is solidified, so that the mandrel is the last part to contract.

Points for Young Moulders.

Metal poured on moulding sand creates gases.

When iron is poured into a mould these gases pass out through vents prepared for that purpose, or through the open portions of the sand.

These gases may pass off in a right way or a wrong way; when iron bubbles or boils, they are passing off the wrong way.

When gases pass up through the iron, it is because the sand is rammed too hard or is not properly vented.

Hard ramming closes up the porosity of the sand, but the vent wire opens it.

Too much water used in mixing sand creates too much steam when the mould is poured.

Steam accumulating under liquid iron, will raise and blow it up.

When iron bubbles or boils in a mould, the casting will be scabbed or bad.

Iron, if poured on a hard bed, will bubble and fly.

In plain copes or top parts the gases and steam are on top of the iron.

In beds or bottoms of moulds, the gases and steam are underneath the iron.

Gases or steam do not act well underneath hot iron; so the bottom portions of rammed moulds should always be provided with sufficient vents to let the gases and steam escape easily.

If there is not sufficient vent for gas and steam to escape downwards, it is seldom that there is a pressure or body of iron large enough to keep them from passing up through the iron.

The harder the ramming, the more need for plenty of vents.

There is less gas created with old sand than with new.

Facing-sand, or sand having blacking, flour, or sea-coal mixed in with it, creates an increased amount of gases.

The greater the surface of a mould, the more venting is required.

Avoid using the swab as much as possible when finishing a mould.

Finishing moulds by often using the swab makes rough, scabby castings.

Never patch a mould with a trowel when it can be patched with the hand or fingers.

The less sleeking done in order to properly finish a mould, the better will the casting be.

Never sleek twice where once will do.

Patching a mould with the fingers will never cause a scabby casting, but too much sleeking patching will.

When finishing, the lighter the moulder bears upon his tools the better.

Heavy sleeking closes up the pores, and makes the surface of the mould hard.

A hard surface-sleeked mould is apt to cause "cold shut," and thin scabs on a casting.

The dryer sand can be worked for practical use, the better, and the more ramming it will stand.

The more ramming a mould will stand, the more strain can be put upon it. These last three points should be specially observed for heavy castings.

A mould that needs to be poured fast, should generally be well vented, and well made.

It is not necessary to jab a pattern full of holes in order to vent the mould.

Whenever it is necessary to cut out the bars of a top; bear in mind that bars in a top are put there to hold or lift up the sand.

If possible, avoid having gaggers sticking up above the top part, as by this many a casting has been lost.

Avoid, as far as possible, using thick, heavy gaggers.

Always make sure of having two-thirds of the length of a gagger between the bars when a body of sand has to be lifted. The sand between the bars holds the gaggers, and the sand below the bars should be lifted by the gaggers.

If there is not sufficient depth of sand between the bars, wooden soldiers should be tacked on the bars to assist the gaggers. Of course this only applies where wooden boxes are used.

"F.T.J." Bookshelf.

Modern Steam Boilers—The Lancashire Boiler.

By W. D. Wansbrough. London: Crosby, Lockwood & Son, 7, Stationers' Hall Court, Ludgate Hill, E.C.

This is a practical manual for owners and users of steam boilers, and deals with the class of boiler which has, perhaps above all others, stood the test of time and varied conditions. The Lancashire, or double-furnaced internally-fired boiler, has for many years been the standard stationary boiler in Great Britain, and a hand-book dealing with with such a furnace is sure to find a wide circle of readers. The author has dealt very thoroughly with his subject and has presented a lot of most useful information for all those concerned with the use of boilers. He opens with a historical sketch of the evolution of the class of boiler under discussion, and then proceeds to deal with its structural strength, the methods of manufacture and inspection during construction. Not the least important is a chapter of advice to boiler attendants, which is well worth careful attention. Following a brief chapter on the legislation on steam boilers, several examples of Lancashire boilers are described and illustrated. The closing chapter deals briefly with the Yorkshire boiler, a modern variant of the Lancashire boiler. The book throughout is well illustrated, and though it presents a lot of matter it is so concisely written as to appeal directly to the practical man.

Reorganisation and Costings.

By Harvey Preen, F.C.A. London: Simpkin, Marshall, Hamilton, Kent & Company, Limited, 4, Stationers Hall Court, Ludgate Hill, E.C.

This is a new and much enlarged edition of a book for manufacturers and merchants which was first published three or four years ago. Its object is to point the way to increased profits by internal reorganisation, the elimination of waste, proper testing systems of raw materials, useful interior factory accounting, and by the introduction of efficient costings. The value of percentage comparisons in regard to purchases, wages, and general costs is fully explained, and there is an excellent chapter on banking, auditing and the value of budgets in business. Diseases of balance-sheets and profit and loss accounts are also fully explained, and much valuable information is given as to the true and correct manner of costing goods, both generally and particularly The author indulges in some really straight talking on the way some businesses are mismanaged, and though many of the points he makes appear quite obvious, they are just the ones that are overlooked in daily business life. The book, if carefully read, should be valuable to many business men and organisers.

D

Correspondence.

Carbon in Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Regarding the correspondence in your last issue, it is interesting to have the opinion of two practical men. Before Mr. Parker can satisfactorily reply to the request of "S. M." it will be necessary to describe on paper the peculiarities of several grades of iron, such, for example, as the close ones which melt open, and the open ones which continue to be open even when melted with large percentages of steel. "S. M." is quite right in asserting that the grade should represent the structure. Practical experience of blast-furnace operations will soon dispose of any opinion that grade can be represented by chemical analysis, even if the correct C.C., Si., and S. are included. Again, "S. M." is quite correct: the grain of the iron has an influence quite apart from chemical analysis.

Poor practical "Moldeo" does not claim to be a scientist, yet one of our leading scientific men has stated that science is but knowledge! Perhaps now "Moldeo" will lay aside his modesty, even if he dared to go no further than practical experience, for that is where the theorist is not a scientist. Perhaps also it is some consolation to "Moldeo" to know that after several years of practical experience I hold similar opinions to his on fracture, and constantly coming into contact with practical men of long-standing, I have yet to meet the first who does not believe in fracture appearance. What about Mr. Pilkington, Mr. Sidney G. Smith, and others? Sound wheel bosses and castings which will not "weep" can be, and are, regularly produced from irons mixed by fracture appearance only, but that cannot be said of the most ideal analysis as such.

Yours, etc.,

E. ADAMSON.

Sheffield, April 14, 1913.

The Contraction of Cast Iron.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Those foundrymen who had not the pleasure of hearing Mr. Sidney G. Smith, of Bradford, read his Paper on "The Composition of Cast Iron in Relation to Fracture," before the Lancashire Branch of the British Foundrymen's Association, must have read with considerable interest the report which appeared in the April issue of your Journal. Mr. Smith, in the course of his remarks, made the following statement:—"Why an open-grained soft iron should not contract as much as a close-grained dense iron, is not so problematical as why a thin section should contract more than a thick section, when the iron is the same quality, unless it is dependent upon the state the carbon assumes when cooling; probably the same law is operating and obeyed in both cases. In the former the low and high specific gravity largely accounts for the difference. Regarding the latter, this is due to the percentage of combined carbon, which is controlled by the rate of cooling."

In these remarks is embodied a problem in foundry practice, a definite finding upon which is anxiously awaited by practical foundrymen, viz., why a thin section should contract more than a thick section when cast with the same metal and under the same conditions. Not only is this the case, but we find in many castings, especially those of a channel section, a different contraction, taking place at different parts of the same casting without any alteration in its thickness, and as a result warping, and in some cases fracture, takes place.

In a short Paper which the writer read before the British Foundrymen's Association in 1911 on "Warping in Castings of a Channel Section," the following suggestions were put forward as to the probable cause of this variation in the contraction of castings cast with the same metal and under the same conditions:—'Variation in the contraction of castings cast with the same metal and under the same conditions is the result of a want of balance in the rate of cooling, and may occur in castings of the same thickness throughout, but where one part cools faster than another, or when there is a difference in the thickness of the casting." It was also stated that, "If two bars be cast, one of light section, and the other of heavy section, the whole of the iron in the casting of light section would have finished the actions arising from liquid shrinkage before the actions arising from contraction commenced, whereas these two actions occur simultaneous in the heavier casting. When the iron has filled the mould for the casting of a heavy section, the cooling first takes place on the outer surfaces of the casting and in a thick casting it may be possible to have the surfaces in a solid state while the metal at the centre is still in liquid form."

Now the outer surfaces of the casting cannot contract to their full or natural extent on account of the resistance of the metal at the centre, which might be said to be at "pattern length," while the outer surfaces which have started to cool are trying to get to what might be termed "casting length." As this contest of forces proceeds, and a decision of some kind must be arrived at, a compromise is arranged, with the result that the outer surfaces which cooled first relinquish some of their contraction and finally set in a state which might be called "stretched." The metal near the centre of the casting which sets at a later stage, endeavours to contract to its natural or "casting length," but it in turn is held by the outer surfaces which have exhausted their contraction; therefore the metal at the centre must also set in a stretched condition, and thus the casting as a whole is not allowed to contract to its natural extent. In the case of the light-sectioned casting the body of metal in the casting is not sufficient to allow of this double or stretching action taking place, and it therefore contracts to its natural extent.

Might we not deduce from the foregoing that it is this stretching action which takes place in the casting of heavy section that allows the carbon in the iron to sweat or separate out to fill up the spaces between the crystals of the iron, as these spaces must be filled up in some way, the specific gravity of the heavy casting then being less than that of the light casting.

In the case of the light casting these spaces do not occur, as the crystals are allowed to build themselves closely together and finally solidify in this manner, thus preventing the carbon from separating, or in other words, retaining it in its combined form.

The foregoing deductions are those which present themselves to the writer in trying to reason out a solution to this problem. Any information on the subject would be greatly appreciated.

Yours, etc.,

R. R. MCGOWAN.

Glasgow.

Inventions.

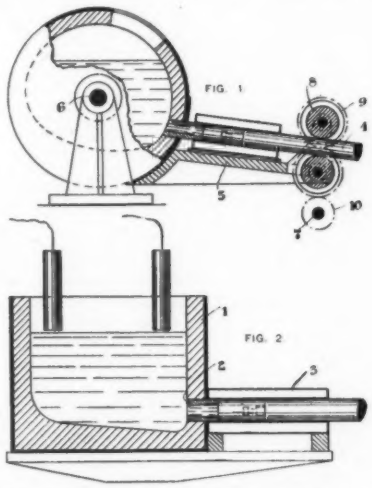
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

6,530. Production of pig-iron or cast-iron from steel scrap and the recovery of by-products. A. W. Gregory.
6,660.*Ingots and ingot moulds. E. Gathmann.
6,832. Furnaces. A. S. Goldie.
6,847.*Crucible furnaces. S. N. Brayshaw.
6,928.*Moulding sector arm cores for belt-pulleys. Fried. Krupp Akt.-Ges. Grusonwerk.
7,693.*Process of and apparatus for determining the Eldridge.
7,103. Metal alloys. L. Goldmerstein.
7,399. Kilns for annealing iron castings. G. B. A. Gibbons, R. Masters, and M. V. Marle.
7,409. Process for refining copper. W. S. Rockey and H.
8,080. Siemens regenerative furnaces. A. Banon.
8,125.*Casting metals by the lost wax process. E. Ferrari.
8,166.*Production of aluminium from its compounds. G. Giuline.
8,284.*Casting of metals. F. Melaun.
8,474.*Crucible and melting-pot furnaces. L. F. Tooth.
8,490. Process for casting and then forging or rolling ingots, from two or more metals. F. Melaun.
8,847.*Manufacture of cores and other foundry accessories of loam. A. G. H. Steegh and Steegh & Esser.
9,098.*Sand-moulding machines. (Soc. Anon. des Etablissements Ph. Bonvillain & E. Ronceray, France.)
9,099.*Sand-moulding machines. Soc. Anon. des Etablissements Ph. Bonvillain & E. and E. Ronceray.

Abstracts of British Patent Specifications recently accepted.

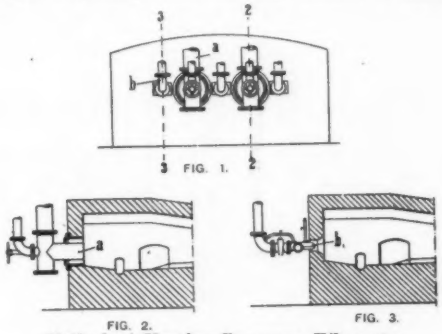
8,485 (1912). *Apparatus for Producing Bars, Tubes, etc., Directly from Molten Metal.* A. H. Pehrson, 6, Kaptensgatan, Stockholm, Sweden.—Fig. 1 shows a stationary apparatus, and Fig. 2 a tilting apparatus. 1



Apparatus for Producing Bars, Tubes, etc., Directly from Molten Metal.

is a furnace or tank containing the molten metal to which a mould 3, provided with a cooling jacket, is connected by a short tubular mouthpiece 2. This mouthpiece is conical or tapers towards the furnace, and is fixed in such a way as to form a non-cooled continuation of the mould to the metal bath in the furnace or tank. 4 is a bar-shaped mandrel fitted to the mould; it serves at the start partly as a plug and partly for the purpose of pulling or moving forwards the casting after its solidification and adherence to the mandrel. In the tilting apparatus the support 5 is applied to the mould, and supports in addition in its prolongation two rolls 8 between which the mandrel bar is moving. The rolls are operated by two toothed wheels 9. When the apparatus is tilted on the trunions 6 into its working position, one of these toothed wheels gears with the pinion 10 fitted on the driving shaft 7, whereby the rolls are put in motion and the bar 4 is pulled forwards.

26,695 (1912). *Heating of Furnaces, Kilns, Etc.* Georgs-Marien-Bergwerks-und Hütten-Verein, Aktiengesellschaft, Georgsmarienhütte, near Osnabrück, Germany.—Fig 1. illustrates an end view of the burners; Fig. 2 is a longitudinal section of the furnace, with a sectional representation of one top gas burner on the line 2—2 of Fig. 1; and Fig. 3 is a section on the line 3—3 of Fig 1. *a* are the top gas burners which are arranged alternately with auxiliary burners *b* fed for

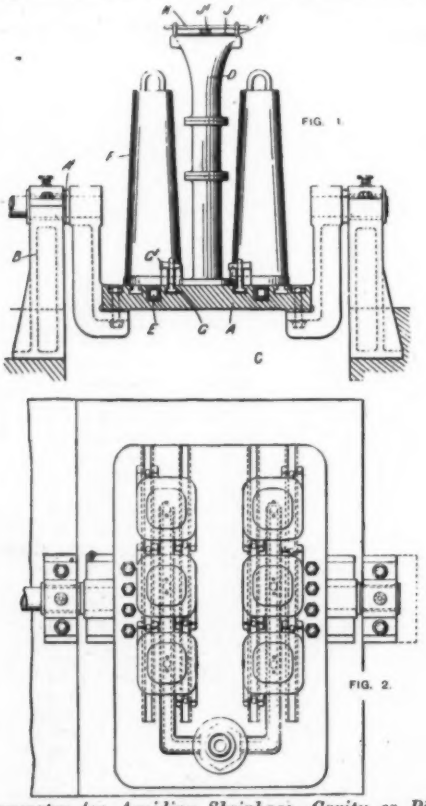


Method of Heating Furnaces, Kilns, etc.

instance with tar oil. The top gas burners are connected to a top gas conduit, and the auxiliary burners are attached to a tar oil conduit. As soon as the pressure in the top gas conduit commences to fluctuate it is only necessary to open the tar oil conduit whereby the tar oil is instantly ignited at the terminal or mouth of the auxiliary burners and supplies those heat quantities to the kiln which are required to supplement the action of the main or top gas burners.

14,130 (1912). *Manufacture of High Carbon Steels.* C. P. Williams, the Gables, Lodge, Wrexham; and the Brymbo Steel Company, Limited, Brymbo.—This invention is an improvement in a former invention, No. 1,293 of 1912, so as to extend the invention to high carbon steels in which a highly carbonaceous material is used to complete the steel. The entire process is the same as that set forth in the original patent, except that instead of ferro silicon there is placed in the ladle charcoal, coke, anthracite, spiegeleisen or other iron alloy high in carbon. The actual process consists in placing a measured amount of the carbonaceous addition in the weighing ladle, and also pouring into the receptacle a measured amount of steel from the furnace, the supply of steel being stopped short when the required measure has been passed, and at a point considerably below the slag, so that no slag can by any possibility be run in. The two are now mixed together, preferably by pouring into a second ladle, and are cast in the ordinary way. By this means all complications such as passing metal from one hearth to another using three or more ordinary ladles or an electric ladle or furnace and other complications are avoided, and a high carbon steel is obtained in a minute or two, free of phosphorus from a basic open hearth furnace. This result is obtained through the basic slag remaining in the furnace above a layer of metal so that not even the higher layers of metal in the furnace which contain particles of slag in suspension are allowed to pass into the ladle.

5,954 (1912). *Process for Avoiding Shrinkage, Cavity or Pipe in Ingots.* J. R. Hoyle and A. W. Brearley, Norfolk Works, Sheffield.—Fig. 1 is an end elevation partly in section; Fig. 2 is a plan. The apparatus comprises a casting plate A provided with trunnions A^1, mounted in standards B disposed on either side of a pit C. The casting plate carries the trumpet pipe D, which communicates by means of runner brick conduits E with the base of each of the moulds F, six of which are shown in the construction illustrated. The moulds are secured in place on the casting plate A by means of T-bolts and cotters G, G^1 in the usual manner. A circular hole E^1 is formed in the runner brick central with each mould, and above each aperture E^1 is placed an annual slab or disc of firebrick H^1, the aperture in which corresponds with the hole E^1. Resting on the slab H^1, so as to extend a short distance upwards from the base of each mould, is a short sleeve or dozzle of firebrick H, the taper of the mould and dozzle maintaining the latter in place after the moulds have been



Apparatus for Avoiding Shrinkage, Cavity or Pipe in Ingots.

inverted, or alternately the mould may be recessed at the bottom end and the dozzle made to fit accordingly. The moulds are filled in the usual manner through the trumpet pipe D, the open end of which is then covered with damp sand and closed by means of an iron plate J, held in place by a wedge J^1, which passes under a locking bar K mounted in lugs K^1 formed on the trumpet. At this stage the entire casting plate A, together with the moulds F secured thereto, is rotated about the trunnions A^1 by any suitable mechanism (not shown) so that the moulds are inverted, and in this way the dozzles H and plates H^1 brought to the upper ends of the ingots. When the molten metal is poured through the trumpet D it rises through the dozzles H into the conical moulds F, and in so rising heats the dozzles H and plates H^1 to incandescence.

New Companies.

London Metal Company, Limited.—Capital £100 in £1 shares. Registered office: Albert Works, Chatsworth Road, Stratford.

Rother Steel & Foundry Company, (Limited.—Capital £2,000 in £1 shares. Registered office: Calder Works, Thornes, Wakefield.

Illumination, Limited.—Capital £100 in £1 shares, to carry on the business of engineers, etc. Registered office: 5, Thavies Inn, E.C.

W. J. Vicary (Merton), Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers. Registered office: 4, Suffolk Street, Pall Mall, S.W.

Sydney Westall & Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers, etc. Registered office (*pro tem.*): 74, Great Portland Street, W.

Isca Foundry Company, Limited.—Capital £50,000 in £10 shares, to acquire the business carried on at Newport, Mon., as the Isca Foundry Company, and to adopt an agreement with A. H. Laybourne and R. C. T. Laybourne.

Samuel Lomax, Limited.—Capital £5,000 in £1 shares (3,000 6 per cent. cumulative prefered ordinary and 2,000 6 per cent. cumulative deferred ordinary), to carry on the business of engineers, etc. Registered office: Rivington House, Woodford Wells, Essex.

Wm. H. Wood & Lamplugh, Limited.—Capital £8,000 in £1 shares (500 deferred), to take over the business of a manufacturer of and dealer in brass and brasswork carried on at Tyseley, Birmingham, as the Wm. H. Wood Brass Fittings Company. Registered office: King's Road, Tyseley, Birmingham.

Parliamentary Notes.

Companies Acts Amendment Bill.

In the House of Commons, on April 1, Mr. J. Hope obtained leave to introduce the Companies Acts Amendment (Co-partnership) Bill, the object of which is to promote the adoption of co-partnership by statutory and other companies, by providing that they should be at liberty to adopt co-partnership without a change in their articles of association. The Bill was read a first time.

Eight Hours Working Day.

The text has been issued of a Bill, presented by Mr. W. Thorne, to limit the hours of employment to eight per day. The Bill enacts that from January 1, 1914, no person shall work or cause any other person to work in any capacity under any contract or agreement, or articles for hire of labour, or for personal service (except in case of accident) for more than eight hours in any one day of twenty-four hours, or for more than forty-eight hours in any week. Any employer, manager, or other person, who shall knowingly cause any person to work for more than the stipulated number of hours, shall, on conviction, be liable to a penalty of not less than one hundred pounds, and not more than five hundred pounds for every such offence.

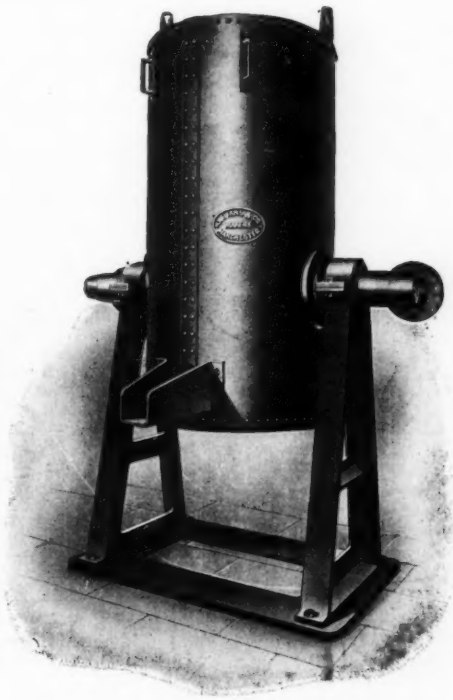
Theodore Butler, Limited, 149, Queen Victoria Street, London, E.C.—This Company have forwarded a copy of the comprehensive catalogue issued by the Chisholm & Moore Manufacturing Company, for whom the are the European agents. The catalogue covers a wide range of small tools for engineers and others, lathes and lathe tools, drilling machines, wood-working machines, weighing machines, roller bearings, hangers, ring oiling hangers, plummer-blocks, compression couplings, etc., while special mention may be made of the "Cyclone" high-speed chain hoists in various patterns.

AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.



James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Trade Talk.

ALFRED HERBERT, LIMITED, have removed their Birmingham office to 75, Exchange Buildings, New Street.

PLANS have been prepared for extensions to Sir W. G. Armstrong, Whitworth & Company's works in Openshaw, Manchester.

MELDRUMS, LIMITED, of Timperley, near Manchester, have moved their London office to 92, Grosvenor Road, Westminster, S.W.

THE address of Messrs. G. A. Harvey & Company, engineers, etc., is now the Greenwich Metal Works, Woolwich Road, S.E.

A PETITION for the compulsory winding-up of the Foster Engineering Company, Limited, has been dismissed in the Companies' Winding-Up Court.

IN the Chancery Division, Mr. Justice Swinfen Eady has sanctioned a scheme for the reorganisation of the capital of Job Day & Sons, Limited.

MESSRS. HEAP & DIGBY, formerly of 28, Victoria Street, Westminster, London, S.W., have removed to 48, Westminster Palace Gardens, Victoria Street, S.W.

THE premises in Dartmouth Street, Birmingham, of Messrs. Vaughan Bros., ship-tackle and edge-tool manufacturers, have been severely damaged by fire.

ARTHUR REINER & COMPANY, LIMITED, inform us that they have removed to larger premises at Parliament Mansions, Victoria Street, Westminster, London, S.W.

BEFORE the members of the Liverpool Engineering Society, Mr. A. Home-Morton has read a paper on "The Lay-out, Design, and Equipment of Industrial Works."

THE pattern shop and offices at the boiler works of Garner, Telford & Hardman, Limited, Cobden Street, Pendleton, Manchester, have been considerably damaged by fire.

MESSRS. WATTS BROS., engineers, Cambridge Street and Wellington Street, Sheffield, have acquired the works recently occupied by W. & T. May, Limited, in Keeton's Hill, London Road, Sheffield.

MR. H. A. SIMMONDS, brassfounder, of New Charles Street, Goswell Road, and Hall Street, City Road, London, who traded as F. H. Simmonds, is paying a first and final dividend of 1s. 3d. in the £.

FIRE broke out in the joiners' shop at the works of Samuel Fox & Company, Limited, steel manufacturers, Stocksbridge Sheffield, and spreading to the laboratories destroyed the building and its contents.

ARTHUR ROSS, HOTCHKISS & COMPANY, LIMITED, boiler composition manufacturers, 1, Glengall Road, Old Kent Road, London, S.E., have acquired the business of the Steel Paint Company, 37, Gracechurch Street, London, E.C., and Stockton-on-Tees.

AT a meeting of Staffordshire Iron and Steel Institute, held at the Institute, Dudley, on April 5, under the presidency of Mr. Isaac Lester, a paper was read by Mr. David E. Roberts on "The Latest Developments of the Roe Puddling Furnaces."

MESSRS. W. T. HAWKINS & COMPANY, cement and waterproof specialists, Capel Hill, Huddersfield, have recently received very large orders for their material after very severe tests, and have supplied several tons to Sheffield and North Wales.

THE WYCLIFFE FOUNDRY COMPANY, LIMITED, of Lutterworth, have just completed a large extension to their foundry, thereby doubling its capacity, and extensively equipped it with moulding machines. The company have also added a new machine shop for dealing with finished castings.

THE business of Joseph Wright & Company, which MR. R. Player has carried on for many years past at the Neptune Forge, Chain, Anchor and Engineering Works, Tipton, and at 124, Victoria Street, Westminster, London, S.W., has been converted into two private companies with limited liability, namely, Joseph Wright & Company, Limited, and Wright's Forge and Engineering Company, Limited.

MR. T. STANLEY PRICE, who recently relinquished his position as salesman for the Glasgow Iron and Steel Company, Limited, to commence business at Cardiff, has been the recipient of a presentation from the officials and men. Mr. Price has commenced business under the name of Messrs. T. Stanley Price & Sons, and will represent some of the largest firms in Scotland for the whole of the district south of Birmingham. Mr. T. George, of Dowlais, has been appointed as successor to Mr. Price.

THE laboratories of the Department of Non-Ferrous Metallurgy at the Sheffield Applied Science Buildings are now complete, and will form a valuable addition to the facilities at the Sheffield University. The formal opening took place on Thursday, May 1, by Sir Joseph Jonas, who is chairman of the Department of Applied Science. The company inspected the new buildings and the laboratories, after which, in the principal Lecture Hall, Professor J. O. Arnold, D.Met., F.R.S., made a statement as to the aims and objects of the department in its relation to the non-ferrous trades of the city.

MR. JUSTICE SWINFEN EADY has sanctioned a reduction of capital and a scheme of reconstruction of Willans & Robinson, Limited, of Rugby. At the hearing of the case Mr. H. G. Wright said it was proposed to divide the outstanding preference shares into £1 shares, and to write off 12s. a share for each of them. Then they proposed to reduce the ordinary shares by 17s. 6d., making them shares of 2s. 6d., reducing the total issue to £141,665 5s. Then they converted the two classes of shares into stock, and amalgamated them into one class. They also proposed to increase the capital by 30,000 shares of 1s. each, the object of which was to give certain gentlemen who were to co-operate with the company an interest in the ultimate profits of the company.

THE sixth annual staff dinner of William Jessop & Sons, Limited, has been held at Sheffield, Mr. Sydney Jessop Robinson being in the chair. Amongst those present were Mr. A. J. Hobson (chairman of the directors), Colonel Hughes, C.B., C.M.G., and Mr. W. B. Burdekin (directors), Mr. W. H. Thomas (co-managing director with Mr. S. J. Robinson), Mr. C. Howell (secretary), representatives of the firm, including Messrs. W. J. Bailey (Cardiff), M. Chapman (Glasgow), B. Firth (Newcastle-on-Tyne), O. Sewell (Birmingham), and B. Fidler (Manchester). Mr. J. F. Melling was prevented through indisposition from being present. Among the visitors were Mr. Oscar Harmer (of Alfred Herbert, Limited), Messrs. R. H. Unsworth (Ipswich), L. G. Rice (London), E. L. Coxhead (Coventry), C. Hounsfield (Paris), G. H. Gardner (London), William N. Dennison, H. Jeans, and B. H. Marsh.

MR. A. H. DYKES, the hon. secretary of the Association of Consulting Engineers, has just issued the report of the Committee showing that the membership has reached 80. Similar organisations exist in the United States, Germany, Austria, and other countries; and it is stated that an immediate cause of the formation of several of the Associations was the loss and expense caused to manufacturing and contracting firms, and thus indirectly to the public, through the waste occasioned by each firm tendering having to draw up its own scheme and prepare detailed specifications for the work, instead of being able to tender to a definite specification drawn up by one independent expert. A communication has been received from the Belgian Association intimating that, in conjunction with the French Association, they propose to organise an International Congress of Consulting Engineers and Engineering Experts on the occasion of the Ghent Exhibition, and inviting the co-operation of the English Association.

THE trustees for the first mortgage debenture stock of Tannett Walker & Company, Limited, of Hunslet, Leeds, have felt compelled to take steps to protect the interests of the stockholders by appointing a receiver of the works and property of the company. Mr. J. W. Close, chartered accountant, of Leeds, is the receiver. The authorised capital of the company is £350,000 in shares of £10, £50,000 being 5 per cent. cumulative preference, having a priority also as to capital, and £300,000 ordinary, and to March 6, 1912, the whole amount had been allotted fully paid to the vendors and their relatives. At that date were also mortgages, etc., for £139,159.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

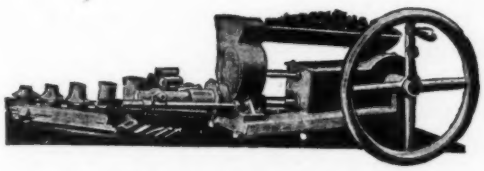
We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

You have no need to experiment in Foundry Plant. We have bought this experience, and guarantee everything we offer. Our special catalogue,

"Modern Foundry Equipment,"

contains the best. Contracts completed and duly inspected for H.M. Dockyards, include Sheerness, Portsmouth, Devonport, Pembroke, Greenock, Gibraltar, Malta, Hongkong, The War Office, Crown Agents for the Colonies, South Australian Government, The Italian and Japanese Navies, English Railways, Dock Harbour Boards, South American and African Railways. . . .



The "Perfect" Patent Core Machine.

Send us your enquiries for.

Tilting Furnaces-Oil & Coke Fired, Moulding Machines, Core Machines, Sand Mixers, Ash Pulverisers & Washers, Mould Driers.

&c., &c. G10

J. W. & C. J. PHILLIPS Ltd., 23, COLLEGE HILL CANNON ST., LONDON, E.C.

Following on the above appointment of a receiver, petitions in bankruptcy were presented in Leeds on April 8 by Messrs. Peckover, Scriven & Company, solicitors, acting on behalf of Mr. Arthur Tannett Walker, managing director of the company, and Mr. F. W. Tannett Walker, also a director. Although this course has been taken in consequence of the position in which the company has been placed, it should be pointed out that the petitions are filed by individual debtors, and that their action concerns only their separate estates, and in no way jeopardises the assets of the company.

The annual report of the National Union of Stove Grate, Fender and General Light Metal Workers, the headquarters of which are at Rotherham, has been issued. In it the secretary stated that all the branches had been benefited by the increase in wages, and nearly all by betterment in conditions. At the end of 1911 the membership was 1,481, and at the close of 1912 was 2,240. During the year two new branches had been formed at Derby and Preston, and the one at Birmingham had been revived. The net income amounts to £3,162 13s. 1d., and £8 17s. 10d. refunds. The total from contributions and entrance fees alone was £2,550 12s. 3d., as against £1,802 10s. 3d. in 1911. Out of work pay in 1911 was £503 5s. 8d., and for 1912 £879 15s., an increase of £374 9s. 4d. Over £400 of this was due to members being out of work during the coal strike. The general funeral benefits showed an increase of £66 15s. from 1911. The dispute pay had increased by £1,000 14s. The total expenditure in 1912 was £3,513 16s. 3½d. as compared with £1,648 2s. 5½d., an increase of £1,865 13s. 10d. The general funds at the end of 1911 amounted to £9,039 13s. 8½d., as against 1912, £8,697 8s. 4d., a decrease of £342 5s. 4½d. Against this they had 2,500 members who were receiving the advance, and which represented a sum that amounted to as much, at least each week, as the loss on the year's working. The advance of April 1, 1912, was 2½ per cent. piecemen and 1s. per week day men; and on February 3, 1913, there was a further concession by the employers.

We have received a draft order of the Secretary of State for the Home Department extending a special exception under the Factory and Workshop Act. The draft is as follows:—In pursuance of Section 59 of the Factory and Workshop Act, 1901, I hereby rescind so much of the Order of the 4th May, 1903, as relates to the night employment of young persons in factories in which reverberatory or regenerative furnaces are used, and in pursuance of Section 54 of that Act I direct that the special exception by which a male young person may be employed during the night shall extend, so far as regards young persons of the age of 16 years and upwards, to that part of any factory in which reverberatory or regenerative furnaces are used and are necessarily kept in operation day and night in order to avoid waste of material or fuel, subject to the conditions prescribed in subsection 1 of the said section and to the following further conditions:—(1) The exception shall apply only to young persons employed in such processes requiring to be carried on continuously throughout the night as are defined in the certificate of the Inspector hereinafter mentioned. (2) Every young person employed in pursuance of the exception shall be submitted by the occupier to the certifying surgeon for the district once at least in every six months for examination at the factory, for which examination the like fee shall be payable by the occupier as for examinations for certificates of fitness in pursuance of the Act and a register of such examinations shall be kept at the factory in the prescribed form and containing the prescribed particulars. (3) No young person who on examination is certified by the certifying surgeon, by signed entry in the register, to be unfit for such employment shall be employed again in pursuance of the exception without the written sanction of the certifying surgeon entered as above. (4) No young person shall be employed in pursuance of the exception unless and until the occupier holds a certificate from the Inspector of the district to the effect that provision has been made to his satisfaction for compliance with the conditions specified in this Order, which certificate shall define the processes to which the exception applies.

Deaths.

Mr. Andrew Pearson, of the firm of Pearson & Ramage, ironfounders, Alloa, died on April 5, aged 67 years.

Mr. A. Cockburn, of Messrs. M. Cockburn & Company, Gowan Bank Foundry, Falkirk, died suddenly at Edinburgh on April 1. The deceased gentleman was a little over 30 years of age, and well known in foundry trade circles.

The death has occurred at Portman Lodge, Bournemouth, of Mr. William Huginn Walker, of Southgate, Endcliffe Crescent, Sheffield. Mr. Walker, who was the son of Mr. W. H. Walker, of Ash Dell, Sheffield, had been in indifferent health for some years. Mr. W. Huginn Walker was formerly a partner in the firm of Messrs. Walker, Eaton & Company, steel manufacturers, of Wicker, Sheffield.

The death has taken place at Benwell, Darlington, of Mr. Thomas Coates, managing director of the Wheasoe Foundry Company, Limited, in his 72nd year. The deceased gentleman had been in ill-health for some time. He went to Darlington in 1891 to take over the foundry works carried on by Messrs. A. F. and H. Kitchens, and the number of employés has been increased in the interval from 100 to 700. Mr. Coates served his time as an engineer and in the drawing office of Messrs. Armstrong's Elswick works.

Personal.

Mr. R. L. Kirby and Mr. Arthur Dorman have been elected directors of Bell Bros. Limited.

Mr. W. J. Richardson has been elected chairman of Richardsons, Westgarth & Company, Limited.

Mr. L. H. Tapps has been appointed to be temporarily an Inspector of Factories and Workshops.

The late J. T. Haigh, of John Haigh & Sons, Limited, Priest Royd Ironworks, Huddersfield, left estate valued at £59,135 gross, with net personalty £58,457.

The late Mr. U. Holborow, formerly one of the proprietors of the Dudbridge Ironworks, left estate of the gross value of £21,878, of which the net personalty is nil.

The personal estate of the late Mr. G. M'Onie, senior partner in the firm of Messrs. G. & J. M'Onie, engineers and ironfounders, of Greenock, has been returned as £4,250.

Mr. J. Lawson, London manager of Ashmore, Benson, Pease & Company, Limited, has been elected managing dirctor of Edward Cockey & Sons, Limited, engineers, of Frome.

The gross value of the estate of the late Mr. William Flint, engineer and ironfounder, a director of Hydes & Wigfull, Limited, of Sheffield, is £5,712, of which £3,946 is net personalty.

It is proposed to erect a monument in the town of Le Creusot, France, in memory of the late M. Henri Schneider, one of the co-proprietors of the Schneider concern, and a son of the founder of the company.

Mr. B. Millington, a director of T. Sheldon & Company Limited, Spring Vale Foundry, Ettingshall, near Wolverhampton, has been the recipient of a presentation from the officials and men on the occasion of his forthcoming wedding.

Major J. D. R. Phillips, V.D., who has relinquished the position of general manager of the Yorkshire Engine Company, Limited, after a connection of five years, has been the recipient of a presentation from the officials and men.

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

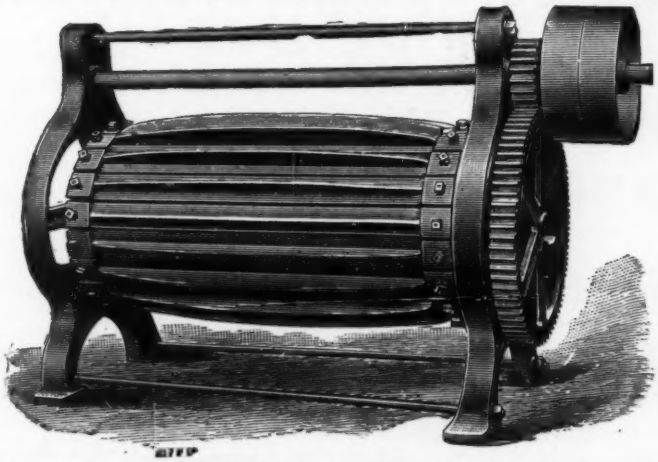
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	End Apl., 1913.	End Apl., 1912.
Iron—Scotch pig warrants ton	*73/-	*60/1½
—Middlesbro' warrants .. ton	67/-	54/2½
—W.C. M/nos Bessemer .. ton	85/-	71/-
—Stock, Middlesbrough ...tons	213,965	1,000
Copper—Chili bars GMB ton	£67 7 6	£70 5 0
—Stock, Europe and afloat tons	— —	— —
Tin—English ingots ... ton	£232 10 0	£208 0 0
—Straits ... ... ton	£231 5 0	£203 10 0
—Stock, London, Holland, U.S.A., and afloat ...tons	10,814	12,117
Lead—English pig ... ton	£18 5 0	£16 17 6
Spelter—Ord. Silesian ... ton	£25 10 0	£25 17 6
Quicksilver (75lb)... bottle	£7 10 0	£8 12 6
Antimony—Regulus .. ton	£32 0 0 £33 0 0	£27 0 0 £27 10 0
Aluminium—Ingot ... ton	£88 0 0 £90 0 0	£67 0 0

*Settlement pric.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	7 7 6	to	7 12 6
Pipes, 1½ to 2½ in.	6 12 6	to	7 0 0
,, 3 to 4 in.	6 5 0	to	6 7 6
,, 5 to 8 in.	6 0 0	to	6 2 6
,, 10 to 16 in.	6 2 6	to	—
,, 18 to 24 in.	6 2 6	to	—
Chairs	4 14 0	to	4 15 0
Floor plates (open sand)	3 10 0	to	3 12 6

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows : Heavy wrought (mixed), £2 17s. 6d. ; light wrought, £1 5s. 0d. ; heavy cast, £3 3s. 6d. ; all per ton, f.o.b., London. Copper (clean), £63 10s. 0d. ; brass (clean), £44 0s. 0d. ; lead (usual draft), £17 0s. 0d. ; Zinc, £19 10s. 0d. ; all per ton delivered merchant's yards.

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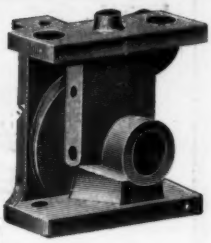

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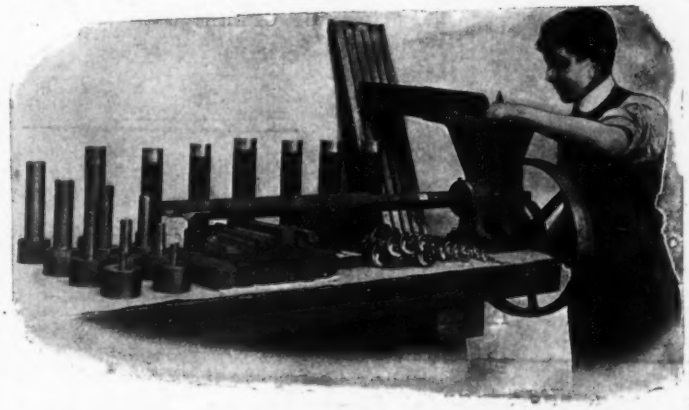

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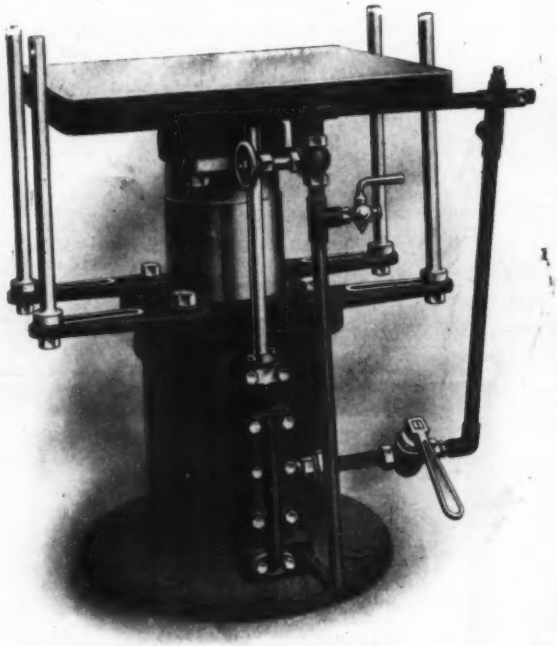

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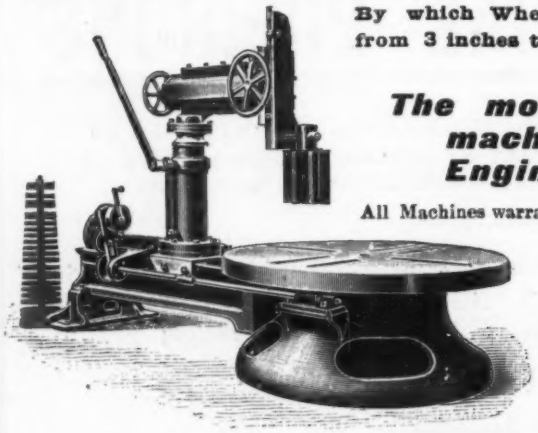

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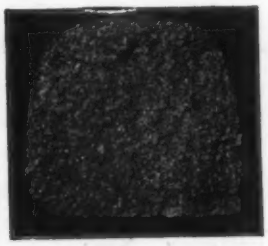
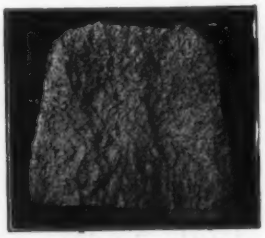

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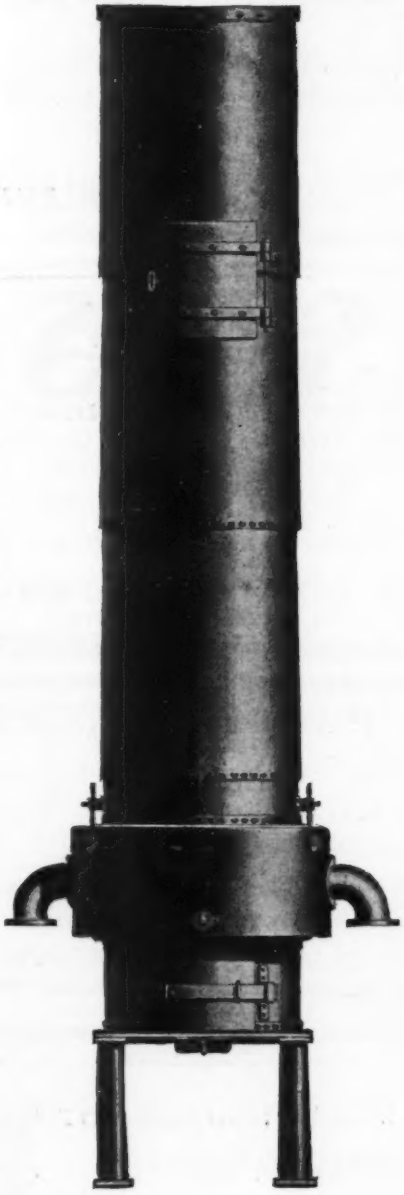

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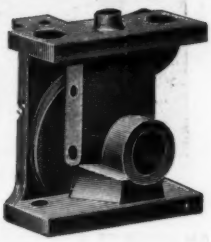

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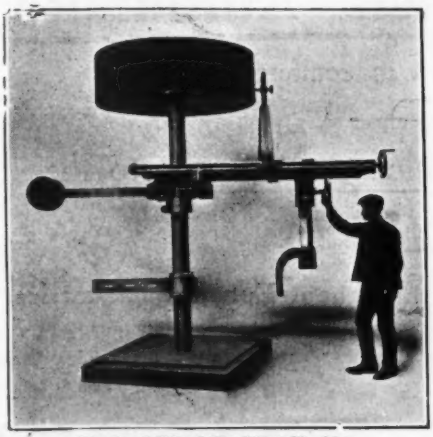

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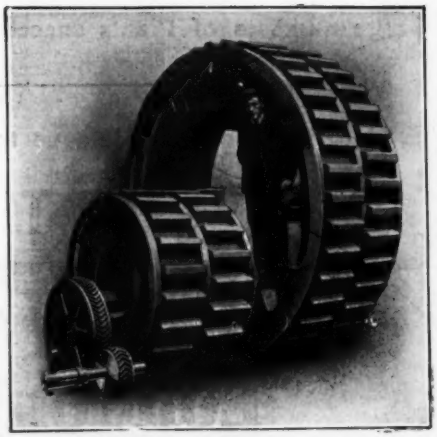

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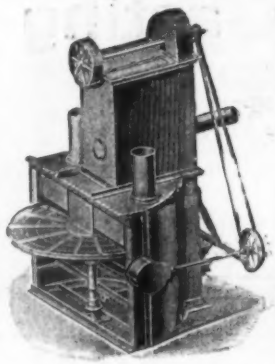

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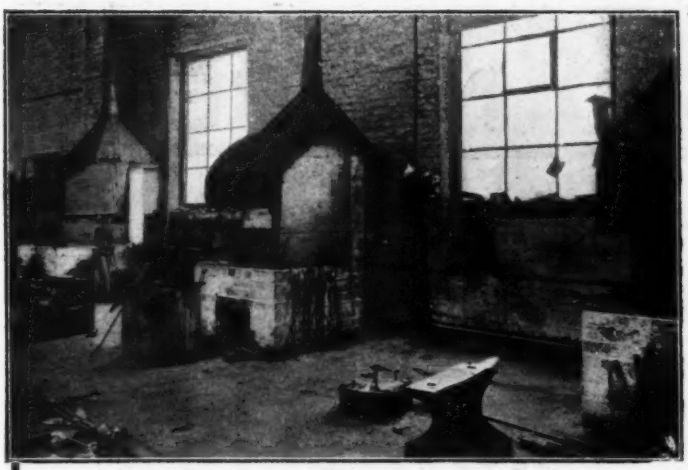

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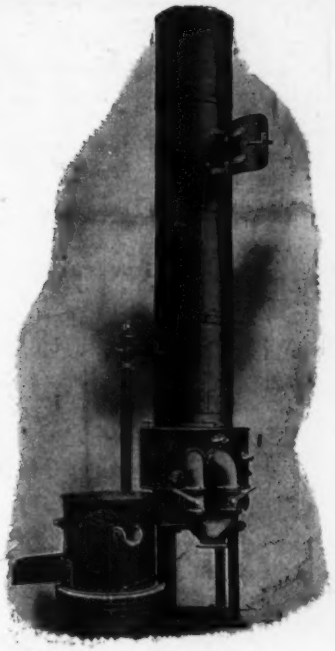

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